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THE FREE-PENDULUM EXPERIMENT PHOTOGRAPHED

By J. G. HAGEN, S. J.

I. Historical Introduction.

Visitors to the Vatican Observatory have occasion to see on the wall of the clock room a photograph of pendulum vibrations, which shows some details that often appear to be new even to scientists. It is Foucault's experiment made and photographed in the southern hemisphere. The picture is nearly two meters long. The deviation of the oscillations is counter clock-wise and the single vibrations gradually widen into oval forms, as they shorten. The unsymmetrical shape of the ovals indicates that the motion of the pendulum ball along the ovals was in a clock-wise direction.

1. The history of this photograph goes back to the time when the first volume of the Vatican Observatory (Astronomical Series I) was written.[1] In that volume all the repetitions of Foucault's experiment are described. A search in the literature revealed the fact that not a single reliable experiment was ever made in the southern hemisphere, although it was known that the deviation of the pendulum oscillations should be apparently contrary to that in the north.

There is, indeed, a report in the Paris *Comptes Rendus* (1851) of an experiment made in Rio de Janeiro, but the description is so confused that, after repeated reading, one does not know in what direction the pendulum deviated. The experimenter tried to define angular velocity by linear velocity (east-west, right-left) but omitted to say what part of the vibration he referred to. Besides, his pendulum was little more than four meters long and the suspension was so imperfect that in some directions of azimuth there was no deviation at all.

The writer then tried to interest some scientist of the southern hemisphere in this matter. A suitable point seemed to be Santiago de Chile, but a letter to an elderly professor of physics remained unanswered. In 1914 a visitor, Father Wilfrid Ryan S.J., then assistant at the seismological station at Riverview College, Sydney, called at the Vatican Observatory. No persuasion was needed to make him enter into the plan. On his return to Australia he communicated the matter to his director, Father Pigot, S.J., who accepted the offer with enthusiasm. Thereupon our volume I, which is mentioned above, was sent to him, as well as the book of Professor Garthe in which the experiment made at Cologne is

[1] La Rotation de la Terre, ses Preuves mécaniques anciennes et nouvelles, Roma 1911.

described,[2] together with some instructions on the suspension of the pendulum.

The Lord Mayor of Sydney granted to Father Pigot the use of the dome in the Queen Victoria Markets, the Surveyor-General and several scientists assisted him with the loan of instruments and with advice.

Here was a chance for Father Pigot's great originality. Not content with doing what others had done before him he determined to fix the vibrations of the pendulum on photographic paper. The lead-ball was constructed in two halves. Near the center was placed an electric lamp, with lens a little lower to bring the light to the proper focus, and a battery of two accumulators. The bromide paper was placed on the floor, on a circular support, corresponding in curvature to the length of the pendulum as radius (see Figure 1).

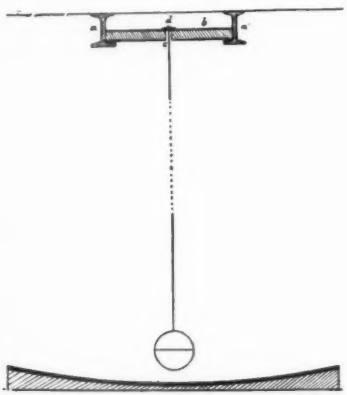


FIGURE 1.

2. This outfit, however, was not yet satisfactory because in the first experiment the single oscillations came so close together as to produce a continuous black surface. Father Pigot's mind was equal to every difficulty. He inserted a watch into the ball, the office of which was to close the electric current once every five minutes. In this way the photograph shown on the Plate was obtained in 1917.

The picture which is now at the Vatican Observatory has a length of 171 cm. It shows in 25 double oscillations an apparent deviation of the last vibration from the first in a counter clock-wise direction. But more than that. The first vibrations seem to be straight lines. Gradually, however, as they shorten, they widen into oval forms. Furthermore, the ovals are not symmetrical curves like ellipses. They are more curved in one half than in the other. Since that half which is more

[2] Foucaults Versuch als direkter Beweis der Achsendrehung der Erde. Köln 1852.

curved is also the following one in time, the photograph proves that the motion of the ball along the oval orbits had a clock-wise direction, contrary to the large deviation of the oscillations from an initial azimuth.

All these points, seen at a glance in the photogram, required in the visual experiments years of studying and discussing before they were generally recognized and understood. The study of the photogram may with advantage be supplemented by an account of how slowly and gradually scientists arrived at the full knowledge of what the free-pendulum experiment teaches. From the account it will appear that Foucault understood only one half of his experiment.

II. Foucault's Pendulum Experiment.

1. Foucault observed in his physical laboratory at Paris that an elastic rod retained its plane of vibration even when turned on the lathe. There was the chance for genius. Replacing the lathe by the rotating earth and the rod by a pendulum, he made an experiment which was indeed, not new, having been made two hundred years before him, but with the difference that he understood part of what the pendulum told, the others not even that.

About the year 1661 or somewhat earlier, Viviani in Florence observed that the oscillations of the pendulum turned constantly to one side. A drawing, which he made, even shows that the turn had a clock-wise direction. Had Foucault been aware of the fact he would, without any further experimenting, have read the truth from Viviani's report.

Foucault made the experiment first for himself in a cellar—it was on the 8th of January, 1851, at two o'clock in the morning—; then, before the astronomers, in the meridian room of the Observatory, and shortly after, at the request of Louis Napoleon, for the public in the Pantheon. On the second of February Arago, then secretary of the Academy of Sciences, gave that body of scientists official notice of Foucault's great achievement.

This achievement, however, did not consist in the experiment only. Foucault also stated the law which the deviations of the pendulum must follow on different parts of the earth. Knowing that, at the poles, the deviation must amount to a full rotation in a day, and that it must entirely disappear at the equator, the *sine* seemed to be the simplest mathematical function to satisfy the two conditions. Thus Foucault was able to compute in advance how much the pendulum should deviate in the Pantheon.

This law, known as Foucault's *Sine*-law, was first proved by Bizet, member of the Academy. Calling ω the angular velocity of the earth's rotation and ϕ the geographical latitude of the place, Binet decomposed ω, by a theorem of Euler, into two components, one with the vertical through the suspension as axis and the other with an axis tangential to the meridian. The two components are expressed by $\omega \sin \phi$ and $\omega \cos \phi$. The reference line for observing the former component is the swinging of the pendulum, kept in constant direction by inertia, while the latter

component shows itself in the transits of stars, and is familiar to every astronomer.

2. No sooner had Foucault's experiment become known than repetitions were made all over the civilized world, in cathedrals, domes, and public halls. The common method was to draw the pendulum from its vertical position, then to tie the ball with a fine thread to a hook, firmly fixed on the side wall or a pillar and, after it had come to apparent rest, to burn the thread. Today the thread would be replaced by a fuse to be melted electrically, because even the approach of the experimenter causes the air to disturb the ball.

He who desires to know the particulars of these many experiments will find a complete historical account in the Vol. I of the Vatican Observatory, mentioned above. One of these experiments deserves special mention because it gave the most accurate demonstration of the *Sine*-law ever made. It was in the cathedral of Cologne, where Professor Garthe could use a pendulum fifty meters long, suspended from the vault of the choir. The experiments were made before thousands of spectators, among them Cardinal Geissel and two members of the royal family. One time the pendulum swung nearly four hours and gave a deviation of 45 degrees. The deviations were measured on two divided arcs and with a chronometer.

In 1902 the Astronomical Society of France inaugurated a repetition of Foucault's experiment, again in the Pantheon, in memory of the great physicist. The minister of public instruction presided and more than two thousand spectators were present. The experiment was resumed on the afternoon of Thursdays and Sundays for the benefit of the public. Accurate measures, however, were never made in the Pantheon.

III. Secchi's Pendulum Experiment.

Together with Foucault's pendulum experiment must be mentioned that made by Secchi in Rome, because it brought out a second property of the experiment, not mentioned by Foucault, and not as readily understood as was the *Sine*-law.

1. Secchi's pendulum was suspended in the nave of Sant Ignazio. By choosing soft iron wire and a perfectly symmetrical suspension, Secchi made his pendulum independent of all directions in azimuth, whereas great and irregular differences were noticed in Oxford, Padua, Bristol, York, Dublin, and elsewhere.

With a pendulum of only 32 meters in length Secchi could not attain the exactness that Garthe reached in Cologne with a pendulum of 50 meters. This, however, refers only to the large deviation, explained by Foucault, because Garthe does not even mention the other property. Secchi brought the oval form of the vibrations to public attention and measured its direction with great exactness.

These ovals, it is true, were not, and could not be, a new phenomenon. They were well known to Viviani and to all subsequent experimenters.

They even appeared stronger with shorter pendulums, but were always considered as imperfections or disturbances of the apparatus. Secchi proved that the ovals are an invariable property of the vibrations, and furthermore, that the motion of the pendulum ball along the oval orbit occurs constantly in the direction of the diurnal motion of the Earth.

Here was the chance for another Foucault to furnish a second mechanical proof of the Earth's rotation, from the lateral velocity of the pendulum ball. It may safely be said that this second proof has not found its way into any other existing textbooks.

2. On the invitation of Secchi the professors of both universities of Rome were present and discussed the experiment. It was readily noticed that the oval form of the pendulum motion works against Foucault's *Sine*-law, and that the ovals widen the more, the more the amplitude of vibration diminishes. Secchi explained this latter point correctly by the law of equal areas. But the mechanical cause of these ovals neither he nor his colleagues discovered.

Evidently Foucault's pendulum was a spherical pendulum. In all experiments it had an initial lateral velocity in the direction in which the Earth turns. But where was the cause of this lateral velocity? How far the scientists were from knowing the answer is evidenced by the many opinions expressed not only in personal discussions but in many treatises, published in the *Memorie* of the Roman Observatory, in Tortolini's *Annali*, in the *Memoirs* of the R.A.S. of London, and in the Paris *Comptes Rendus*, between the years 1851 and 1853. Physical disturbances of the experiment were suspected, such as that caused by the suspension, which indeed turns with the earth, though it cannot impart to the pendulum ball more than a rotation around its own centre; or that caused by the air, which evidently shares the rotation of the observing room and acts against the inertia of the pendulum motion, though its pressure on the heavy ball cannot fully account for the oval form of the vibrations. Even the exactness of the *Sine*-law was called in question. Binet also, the French mathematician, and Airy, the English astronomer, were of the opinion that Foucault's pendulum was not necessarily spherical but would swing in a plane as soon as the imperfections of the experiment were removed.

Chelini reports in Tortolini's *Annali* (1851) of a young Dr. Vescovali whose idea was that the cause of the spherical motion of the pendulum must be due to the rotating earth itself. This was correct, but how the rotation of the earth gives the ball a lateral velocity no one could say. Today it is hardly intelligible that nobody thought of the hook to which the ball is tied and which cannot stand still while the observing room is rotating.

In Tortolini's *Annali* of 1853 appeared the exact formula for the lateral velocity, calculated by Mossotti. Vescovali's idea was the basis of his calculus, and the full amount of the earth's rotation, which according to the *Sine*-law is $\omega \sin \phi$, was attributed to the apparatus. Whether Mossotti was aware of the mechanical connection of this rotation with

the pendulum does not appear from his article. To transform the angular velocity of the ball into linear velocity it was only necessary to multiply the former by the distance r between the ball and the vertical that passes through he point of suspension. In this way Mossotti obtained the correct value $r\,\omega\,sin\,\phi$ for the lateral velocity of the ball.

Poncelet wrote in the *Comptes Rendus* **51** (1860) 515 about the same initial velocity and insisted that it can never be avoided. Theoretically he admitted the possibility of getting rid of it, either by imparting to the ball, when the pendulum is vertically a rest, a central horizontal impulse or, when tied to the hook, to give it a push equal and contrary to the lateral component. Both practical impossibilities. Poncelet treated Foucault's pendulum from the general differential equation of relative motions on the rotating earth, without expressly mentioning the component computed by Mossotti or referring to the hook. Who was the first to state that the pendulum ball, when drawn from the vertical and tied to a hook, is actually in motion, though appearing in perfect rest, does not appear from the literature of the time.

Secchi's merit consists in having proved by exact measurement that the pendulum vibrations are always oval and that the motion along the oval is invariably in the sense of the Earth's rotation, thus diminishing the deviation expected from the *Sine*-law.

3. The effect of the oval motion on the apparent deviation of the pendulum vibrations could be computed even though the mechanical cause of the lateral velocity was yet a mystery. The theory of the spherical pendulum was long known from the works of Clairaut, Legrange, Poisson, and others. For the experiment in question, however, it was not necessary to start from the general theory. Simplifying assumptions were made, such as $sin\,\theta = \theta$, $cos\,\theta = 1$, where θ is the semi-amplitude of a vibration. Also the fraction b/a of the two semi-axes of the ovals was assumed to be of the same order of magnitude as the semi-amplitude θ.

The first computation was made by Airy in 1851. Adding his result to the *Sine*-law we get the corrected apparent deviation of Foucault's pendulum expressed by the two members of the formula

$$-\omega \sin \phi + \tfrac{3}{8}\, ab/l^2 \sqrt{g/l}$$

where l is the length of the pendulum and g the constant acceleration of gravity. Airy computed the second member of the formula only as a correction to the first member. He was not aware, as it seems, that the smaller axis b is originally caused by the rotation of the hook to which the pendulum ball is tied; i.e. by the rotation of the observing room around the vertical that passes through the point of suspension of the pendulum.

In applying the formula to an experiment, the two semi-axes are to be measured at the end of the interval for which ω is computed. The algebraic sum of the two members of the formula should agree with the observed deviation at the chosen moment. The second member will

probably always be smaller than the errors of observation.

Very easy are the measures from a photogram. They can be repeated at will, and would form a good school-exercise. No doubt, making a photogram with an elaborate ball like that of Father Pigot, during quiet night hours, on a long strip of photographic paper, is a very laborious work. But once made it will serve forever as a means of instruction. Although Father Pigot's pendulum can, owing to its moderate length, yield only qualitative measures, the merit of having originated and carried out the first photogram will remain a permanent honor to him.

VATICAN OBSERVATORY, 6 JANUARY 1930.

THE METEOR OF FEBRUARY 16, 1930

By C. C. WYLIE.

At about four o'clock on the morning of February 17 (Civil Time), 1930, Dan Bartholomew, engineer on a Sante Fe passenger train, saw what he thought was an airplane falling in flames, redder flames than that of an ordinary fire. At his next stop, Topeka, Kansas, he wired back to Burlingame suggesting that they there make a search.

In East St. Louis, Illinois, at the same hour, Leonard Morrison, night man at a filling station, saw what he assumed to be an airplane going down in flames near the Park air port. He sent his service man over to investigate.

At Ripley, in western Tennessee, Miss Sarah Given, who had been aroused by a fire alarm, noticed a strange light in the northern window. She raised up in bed, and saw a ball of fire which in a second or so had passed below the horizon. She lay down again, and after an interval of a few minutes, (it seemed at least five to her), the windows were shaken by an explosion like a sharp peal of thunder, or a blast of dynamite. It was severe enough to awaken her mother who had been asleep.

At Poplar Bluff, Missouri, a father was returning from a trip to the doctor. His child was seriously ill, and his nerves were worn from loss of sleep and worry. In his own words—

"I was walking along the road and all at once the earth lit up as light as day. I looked up at the moon and saw a ball of fire with a long tail of fire to it coming out of the east. It looked like it was going to hit me so I run to get out of its way and just before it got to me it burst into flames and went out. In about one minute the earth shook like an earthquake. When I got in the house my wife was crying and said she believed that was a sign our baby was going to die, and we lost our baby four days after that happened."

Near Gainesville, Arkansas, Marvin Penny, a farmer, was dressing when he heard the crash of an explosion, seemingly right over his house. He was outdoors at once and heard a noise like thunder rolling, as it seemed, to both northeast and southwest, the roll to the northeast

being more pronounced and lasting longer. He saw, in spite of the moonlight, a trail like the milkmaids path extending from about 30 degrees altitude in the southwest through overhead to near the horizon in the northeast. This trail was visible for perhaps five minutes in the northeast, where it could be seen the longest. The explosion stampeded Mr. Penny's stock.

Near Beach Grove, Arkansas, two young men, Charlie Norman and Willie Allison, were going fishing. They were driving in a farm wagon when the landscape lighted up, it seemed to them brighter than day. Looking up they saw a ball of fire with a tail to it coming from the northeast. It passed overhead, and went out at an altitude of about 20 degrees in the southwest. The team, accustomed to bright automobile lights, paid little attention to the display, and the boys drove on without change of pace for perhaps a hundred yards. Here, an explosion which jarred things like an earthquake startled the men and caused the horses to plunge. The first blast seemed to come from about where the meteor had disappeared, and following this a roar as though a big train were passing rolled back along the path of the meteor. It crashed back to overhead in "no time," and then on to the northeast, the rumbling being audible for perhaps half a minute. At this point, according to Charlie, Willie wanted to turn around and go back home. However, when they had quieted the team and talked things over, the two men decided to go on with their fishing trip.

In collecting information on bright meteors, we have within the past year sent circular letters to much of the territory where this meteor was conspicuous. The meteor of July 25, 1929, was conspicuous in southern Illinois, Missouri, northern Arkansas, and probably in eastern Kansas. In November, 1929, shadow casting meteors were conspicuous in southern Illinois, Missouri, Arkansas, and eastern Kansas. The interest of many had been aroused by these earlier meteors, and we were notified promptly when this important meteor fell, the first word reaching us from Thos. N. Galey, of Independence, Kansas. Letters requesting information were published in such papers as the *St. Louis Star*, the *St. Louis Post Dispatch*, and the *Memphis Commercial Appeal*, and brought us the names of many who had seen the meteor even though it fell at four A.M. Eventually, observers in three states were personally interviewed.

The final computation of the path through the atmosphere has not as yet been made. Getting the most out of the numerous letters and interviews is quite a task, and some important information which has been promised has not as yet been received. It appears, however, that the meteor came very nearly from the northeast, and disappeared over a point a few miles west of Paragould, in Greene county, Arkansas. The altitude of disappearance comes out about five miles, but the meteor may have burst into three pieces at a height of nearly ten miles. Five miles is a low altitude for a meteor to show as a ball of fire, but we shall see that this was a meteor of unusual mass, and it appears reasonable that

a big meteor would come low.

For the fireballs on which we have been working, one gets two to six seconds by asking observers to "reenact the scene," so that we can time the estimated duration. For this meteor, results similarly obtained vary from six to ten seconds. It is reasonable to assume that the personal element would affect in the same way results on this and the earlier meteors, and so it appears that this one was travelling at a relatively low velocity. This would, of course, give it a better chance to come through the atmosphere unconsumed.

The explosions heard at the time of a meteoric fall are attributed to an effect similar to that causing thunder. The velocity of the meteor is so great that a vacuum is left behind it, and the air closes into this empty space with explosive violence. Olivier has suspected that there are additional explosions at the time a meteor bursts. Numerous persons were questioned carefully on the sounds heard at the time this meteor fell. Unfortunately, nearly all in the vicinity of Paragould were indoors at the time of the explosion, so the results are not so definite as otherwise would have been the case. It will probably be unnecessary to assume more than the thunderclap effect, but we will probably not be sure that there was no other. The sounds indicated reasonably well the points where the two large stones were recovered, and suggested a third large meteorite which has not been recovered.

The letters fix the time of fall quite closely as 16:08, February 16, 1930, C.S.T. (noon to noon reckoning). Several letters are from railroad men, three of whom were interviewed. These men carry accurate time, and are accustomed to noting carefully when anything noteworthy happens.

The Meteorites.

A few hours after the appearance of the meteor, Raymond E. Parkinson, a farmer living near Finch, was going to the field to get his horses when he noticed a hole, with clods of fresh earth scattered chiefly to the northeast. A meteorite weighing about 80 pounds was recovered from the hole, which was measured as 34 inches deep. Parkinson and those who helped him remove it assumed that the stone had struck at a low angle from the southwest, and thrown the dirt in the direction of travel. W. R. Heagler, a civil engineer of experience, examined the hole carefully and reported that in his opinion the stone had come from the northeast, and the clods were thrown northeast because it was downhill, and perhaps because of the shape of the stone and position at the instant of striking. We know the meteor came from the northeast, and from general considerations we would expect the direction of fall of the stone to be nearly vertical at the instant of striking.

This stone was in the possession of the Paragould high school for a time, and then passed into the hands of Stuart H. Perry, of Adrian, Michigan. A description by Mr. Perry appears with our notes in the April issue of this journal, page 406. It is similar to the larger meteorite recovered later and described in the following paragraphs.

On Sunday, March 16, at about 8:30 A.M., W. H. Hodges, a farmer living a few miles southwest of Finch, discovered a big hole near his home, but on land belonging to his neighbor, Joe H. Fletcher. These men, and Pete Smothers, put in a hard day's work, and at about 9:00 o'clock Monday morning brought the big meteorite up. The hole measured 8 feet ¾ inch deep, the bottom deviating about a foot to the southwest. This shows the stone was falling with a slight deviation in the direction of the meteor's travel. Scattering clods of clay were thrown, chiefly to the south, which was nearly in the direction of travel, but also the direction of the slope of the land. These clods were quite numerous at a distance of 30 feet, and some were thrown 50 yards or more.

THE 820-POUND PARAGOULD METEORITE.
Width of supporting stand, 28 inches.

The meteorite measures 26x36 inches, and weighs 820 pounds. I did not personally measure or weigh the stone, but the figures are probably close to the truth. The crust is not pronounced and the surface is not noticeably pitted. In this, the stone is unusual. A good geologist, with no cause for suspecting its meteoric character, might well pass it by as an ordinary terrestrial boulder. A more careful examination, however, shows most of the features characteristic of meteorites. A small magnifying glass shows the protruding grains of nickel-iron, and in thin sections imperfectly outlined chondri can be seen. Dr. F. F. Osborne, of our Geology department, lists the following facts as important.

"a) The material yields blowpipe tests for nickel.

b) It yields scales of metallic iron on pulverization.
c) It contains a sulphide which gives the mineralographic reactions of troilite and gives hydrogen sulphide on treatment with HCl.
d) On the crust, the iron stands in relief and the troilite appears to have formed depressed areas.
e) The iron is cut by veinlets of troilite.
f) In thin section, a matrix of opaque minerals contains unidentified silicate minerals."

PRELIMINARY ANALYSIS BY K. W. RAY.

A two-gram piece broken from near the surface was used for the chemical analysis. In order to obtain the average composition of the entire meteorite, a much more systematic system of sampling would have been necessary; but that was impractical in this case and the fragment was analyzed as follows. After grinding, the sample was heated to redness to expel water, gases, etc., and to oxidize the metallic particles. The sample gained 0.62% in weight during this ignition. The sample was then analyzed using the ordinary methods for silicate rocks. The oxides of titanium, manganese, chromium, phosphorus, and a few other rare elements were not separated from the iron oxide, and are therefore included with it. The results are as follows:

Silicon dioxide (SiO_2)	40.56%
Iron oxide (Fe_2O_3)	28.37
Aluminum oxide (Al_2O_3)	2.30
Nickel oxide (NiO)	1.82
Calcium oxide (CaO)	2.23
Magnesium oxide (MgO)	23.40
Sodium oxide (Na_2O)	0.63
Potassium oxide (K_2O)	0.37
Total	99.68

A NEW RECORD IN METEORITES.

If the weight of 820 pounds is correct, and there is, as we have said, no reason for doubting that it is very close to the truth, the big Paragould meteorite is the largest stone which has been recovered intact. The Long Island, Kansas, stone weighed over 1200 pounds, but it was broken on a ledge of rock in falling. The Knyahinya, Hungary, stone, 647 pounds (293 kilograms), has held the record for stones recovered intact. This stone was also the largest meteorite for which the date of fall was known, but if the account can be trusted, the 20-ton iron from Bezerros, Brazil, has taken that record. Previous to the Bezerros fall, the 107-pound iron which fell near Cabin Creek, Arkansas, was the largest iron meteorite for which the date of fall was known. Arkansas has had the largest iron for which the date of fall is known. It now has the largest stone.

On the week-end following my return from Arkansas, I called at the Field Museum in Chicago, and at about the same time Mr. Perry called

at the American Museum of Natural History in New York City. We wanted the big meteorite to fall into good hands, and so were making sure that the leading museums understood the importance of the meteoric fall. In the meantime, H. H. Nininger, of McPherson, Kansas, enlisted the services of an able Paragould attorney and succeeded in purchasing the stone. Mr. Stanley Field, in turn, purchased it from Professor Nininger, and presented it to the Field Museum, which institution now has possession of the 820-pound Paragould meteorite.

UNIVERSITY OF IOWA, JUNE 4, 1930.

"WHY WE OBSERVE DOUBLE STARS"

By RAYMOND S. DUGAN

The systematic search for double stars, variable stars, and classes of stars of other common characteristics is justified by the pure joy of discovery; by the additional material it furnishes for statistical studies of distribution and of other correlations; and by indicating individual stars that will repay further and intensive study.

Statistical studies require that the search be made extensively and thoroughly. We desire, for example, to know what proportion of stars brighter than a certain magnitude are double. Correlation, however, cannot be followed far or along many lines until individual stars have been given further study and with all available instrumental means. The relative amount of time required results in discovery far outrunning intensive study and in the sad spectacle of the statistician waiting very impatiently on the observer. How much responsibility the discoverer should feel for the further study of his finds and how much he should leave to other astronomers and to other generations are questions that are at least open to argument.

Take, for example, a variable star. It appears as one in a long list of discoveries. It must then be given a preliminary study for the determination of type. The observational material on which the discovery is based sometimes suffices for a somewhat insecure indication of type of variation. If the variation is periodic, the period must be determined by more observation. Possibly the material so far collected is sufficient to determine the general characteristics of the light curve. In any case observation must be continued until it becomes possible to decide whether this particular star has information to offer which will justify an intensive campaign with photometer, spectrograph, micrometer, and photograph.

Before starting in on a long calculation a man first spends hours, days, or weeks, in careful consideration of the best ways in which to make the calculation; so also the hardest part of observing is the wise selection of objects to observe. One of the saddest of sights is a man

observing night after night some object selected almost by chance and which only by chance will turn out to be interesting.

In the field of variable stars, again, the observer, armed with a photometer, limited by other duties, by weather, and by physical frailties, and able on the average to complete one or two light curves a

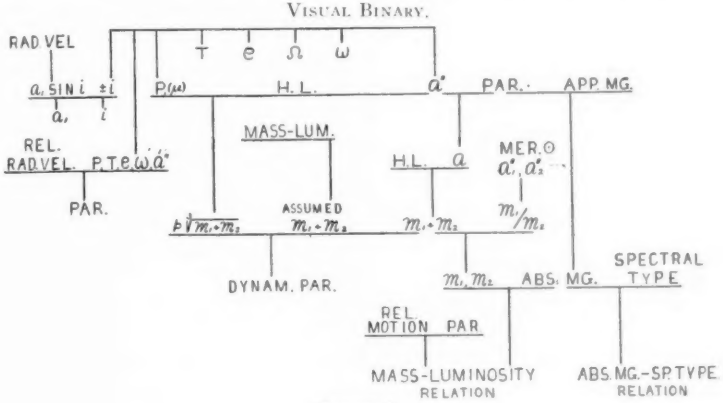


FIGURE 1.

year, must select for observation light curves which, independently of other lines of attack, will furnish many interesting and valuable results. As far as possible, also, he should select stars which have been observed, or which it is possible to observe by other instrumental means, to take advantage of and become a part of a combined campaign.

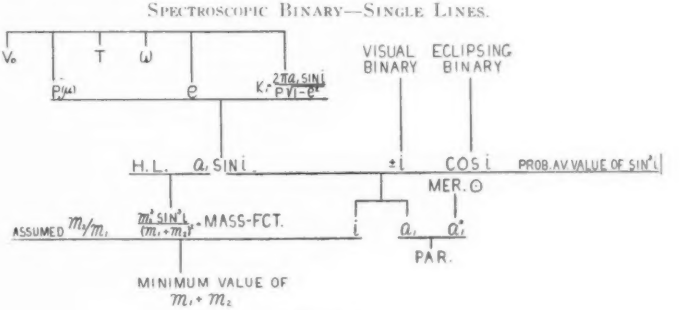


FIGURE 2.

The diagrams in this article have been found very helpful in remembering the many ramifications of double-star observation. They are constructed in the form of family trees but this analogy must not be carried too far. The symbols are standard, with the following sig-

nificance:

P, Period of revolution; μ, Mean motion.
T, Time of periastron passage.
e, Eccentricity.
Ω, Position angle of the node.

SPECTROSCOPIC BINARY—DOUBLE LINES.

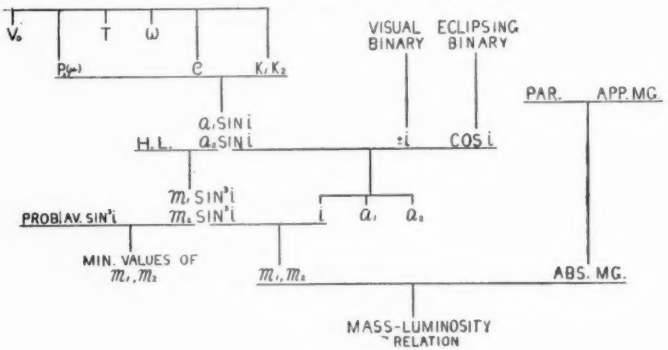


FIGURE 3.

ω, Angle from node to periastron.
i, Inclination.
a'', Semi-major axis of relative orbit in seconds of arc.
a, Semi-major axis of relative orbit in linear unit.

ECLIPSING BINARY.

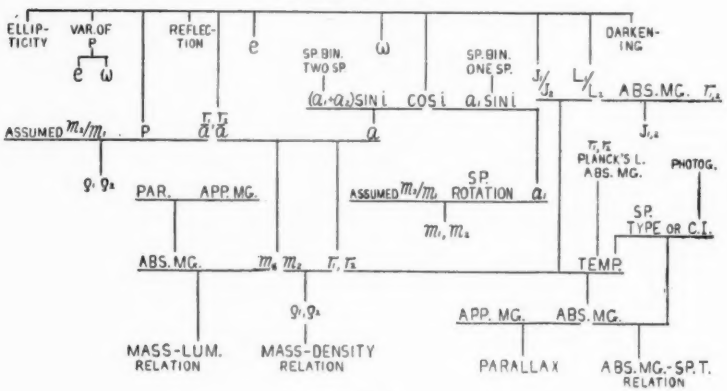


FIGURE 4.

a_1, a_2, Semi-major axes of orbits about center of gravity.
(a_1'', a_2'', in seconds of arc.)
K_1, K_2, Half-ranges of velocity.
V_0, Velocity of system.
p, Parallax.

L_1, L_2, Total light from the two stars.
J_1, J_2, Surface brightness.
r_1, r_2, Radii.
m_1, m_2, Masses.
ρ_1, ρ_2, Densities.

The abbreviations are readily understood with the possible exception of "*H. L.*" which stands for "Harmonic Law." "*Mer.* ⊙" obviously includes photographic measures with reference to neighboring stars.

The pendants from the first line are the various elements derivable directly from one type of observation: micrometric, for the visual binaries; spectroscopic, for the spectroscopic binaries; and photometric for the eclipsing binaries. Combinations of these elements with other assisting data are indicated by the horizontal lines. These combinations lead down to other results which again recombine. In several cases a quantity stands over a break in a line indicating that it combines both with the quantity on the left and with the one on the right.

The exigencies of drafting have produced some curious arrangements but they should be easily understood. In the visual binary diagram it was necessary to repeat the five orbital elements that are used with the relative radial velocity to determine parallax. No attempt has been made to indicate the sources of the assisting data, such as parallax. The diagrams are incomplete, partly from choice to avoid duplication and complexity; partly, doubtless, from other reasons. It has been necessary to refrain from indicating many promising lines along which further combinations will probably be formed.

The diagrams make it evident how essential is the contribution of each observer, and how powerfully the data gathered by different observers strengthen each other, form together, and march forward on nature's most mysterious strongholds.

PRINCETON UNIVERSITY OBSERVATORY, MAY, 1930.

A HOME-MADE TELESCOPE AND OBSERVATORY

By HUGH G. BOUTELL

The following description of my telescope and "observatory" may prove of interest to some of your readers, as showing what can be accomplished in an unfavorable location with limited mechanical facilities and at small expense.

For some time a small refractor was used, mainly for examination of the planets and brighter stars, but during the winter of 1927-28 a six-inch Newtonian reflector was constructed. The making of the mirror naturally occupied he greatest amount of time, but a fair figure was finally obtained. The tube and mounting were constructed largely of wood, since a metal mounting was out of the question with the hand tools available. This mounting is of the usual equatorial type with

circles made by soldering protractors to circular pieces of tin. The eyepiece tube and focusing device are also made of heavy tin without machine work. A cord with a double purchase, fastened either to the lower end of the tube or to the counterweight serves as a slow motion in right ascension.

The telescope was at first mounted on a low tripod, since the wooden construction is light and the whole affair could be easily carried a short distance. However, certain difficulties soon became apparent. It is always hard to set up a portable telescope with sufficient precision to

FIGURE 1.
THE SIX-INCH REFLECTING TELESCOPE.

pick up objects invisible to the naked eye. Likewise, some form of sidereal clock is almost a necessity. Then, too, in the locality where this telescope is used it is very difficult to follow an object for any reasonable length of time from a single set up because of branches of trees, roofs of houses, and other obstructions, to say nothing of street lights shining directly into the tube. It was soon evident that to carry on any worthwhile observations one needs a fixed location, a certain amount of comfort and freedom from interruption, and some one observing station from which the sky line and appearance of the stars are perfectly familiar. Otherwise, much valuable time is wasted.

It became evident that the only solution was to mount the telescope on the roof of the house, from which an almost unobstructed view of the sky for a zenith distance of 75 or 80 degrees can be secured. However, every part of the roof is built on a steep slope and covered with

slate. There was no way of reaching the main roof directly, but there was one small dormer window opening onto the slanting roof of a two-story back porch from which the main roof could be reached.

A platform, guarded by a high railing and "chicken wire," was constructed in pieces in the cellar and assembled on top of this porch roof, supplying a level walk parallel with the eaves of the house roof and about 18 inches below it. Access to this walk is had through the small window and a couple of steps. A tripod stand for the telescope was then erected on the main roof, directly over the 13-inch brick wall of

FIGURE 2.
VIEW OF OBSERVATORY FROM THE GROUND.

the house. The tripod does not stand directly upon the slates, but is firmly nailed to heavy boards which rest for their whole length upon the roof and are prevented from slipping by the gutter. There is no connection between the wooden platform and the tripod, so that motion of the boards of this platform is not communicated to the telescope mounting. Two observing stands were also constructed. These are made so that one end rests upon the sloping roof while a long leg at the other end rests on the platform. The platform, mounting, etc., are entirely out of sight from the front of the house.

Part of the small store room in the attic, containing the window or "door" to the observatory was fitted up with brackets to support the telescope tube and equatorial head, shelves for eyepieces and other equipment, and a small wall desk for books, charts, and notes. A simple radio set with headphones, for obtaining time signals was also installed,

as well as an inexpensive pendulum wall clock, regulated to keep sidereal time. This clock has a calendar attachment normally used to indicate the day of the month, but now employed to show the age of the moon. A long extension cord with a small red electric bulb is used to read the circles, for examining charts, and for making notes at the telescope.

With this arrangement the telescope and equatorial head are indoors and protected from the weather when not in use, yet are set up in two or three minutes, and the telescope is always approximately in the

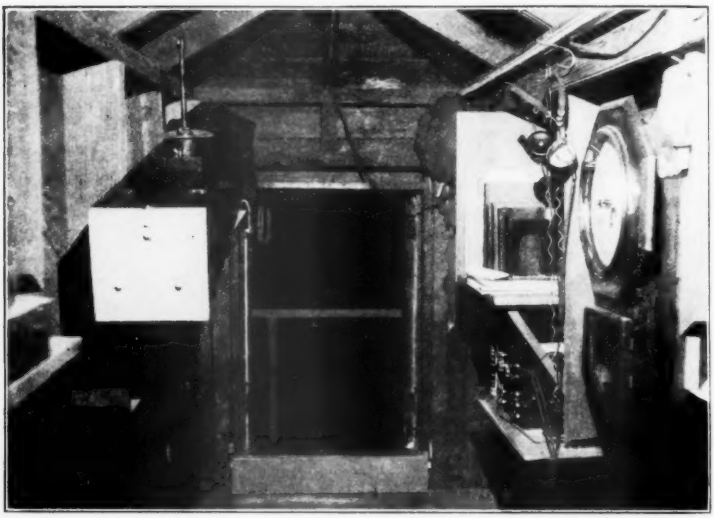


FIGURE 3.
INTERIOR OF OBSERVATORY SHOWING TELESCOPE TUBE ON LEFT, AND RADIO SET ON RIGHT.

meridian. Even with the simple means available it is possible to pick up objects from the ephemeris positions with very little delay. Wind and vibration are the worst enemies of the installation. There is considerable spring in the mounting, so that vehicles moving in the alley back of the house and even in the street in front produce severe tremors in the telescope. Beating eggs in the kitchen is fatal! At night such interruptions are not very frequent, but it is generally hard to use high powered eyepieces with success. Nevertheless, for certain kinds of work, such as observations of variable stars, the arrangement is very satisfactory, and occasionally fine views of the planets and some double stars are obtained with a power of 255X.

The total cost of the telescope, observatory, and equipment was not more than fifty or sixty dollars.

An amusing difficulty was experienced during construction. Practically everything was in place when it was discovered that it was a physical impossibility to carry the telescope tube while stepping out of the window. Likewise, it was impossible for one person to lift the tube through the window and place it safely outside. The Chief Astronomer was in despair till his wife suggested that a rope be hung from the projecting eaves of the dormer to which one end of the tube could be fastened. This works to perfection, as it is only necessary to hook the rope onto the eyepiece end of the telescope, push the tube through the window till the mirror end rests against a nail on the window sill, and then step out alongside the tube, Thus, the success or failure of a project often depends on some apparently minor detail.

The observatory is still "up against it" for some means of keeping accurate time, so that occultations and similar phenomena could be recorded. For approximate settings of the telescope an inexpensive clock, set each day by radio, is satisfactory, but this is valueless to record events. Experiments with a stop watch show that such a time keeper has too uncertain a rate to serve the purpose. In the nature of things, an astronomical clock is an expensive piece of machinery and must be installed in a room where temperature changes are slight. Probably the observatory's program will have to be confined to work in which time is comparatively unimportant.

3723 Jocelyn St., Washington, D. C.

FORTY-THIRD MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

[*Continued from page 130.*]

ABSTRACTS OF PAPERS

THE SPECTRUM OF η CARINAE.

By Bart J. Bok.

Miss Cannon has found that on the early Harvard plates (taken before 1900) η Carinae shows an absorption spectrum with superposed hydrogen emission. Since Merrill's identification of many of the intense lines in the present emission spectrum as due to forbidden Fe II transitions, these early spectra have become of much interest and it seemed worth while to study them in detail.

One plate taken in 1893 with the 13-inch Boyden telescope in Arequipa is of very fine quality. About 70 absorption lines were measured: probable identifications can be found for 42 lines, whereas possible or uncertain identifications can be given for part of the remaining lines. Lines due to Fe I, Fe II, Ti II, Ca I, Ca II, Mg II, Cr II, Sc II, and Sr II are found. Comparison of the line intensities with those in ϵ Aurigae shows that the spectral type of η Carinae is probably cF5.

Twenty-five absorption lines were also measured on a second plate taken in 1893; on these two plates and on a third plate taken in 1892 the spectrum seems to be practically identical.

Superposed upon the absorption spectrum are some emission lines. For the 1892 and 1893 plates the main features of this part of the spectrum are:

1. The Balmer lines (with the exception of Hϵ, being perhaps invisible on account of the strong H-line) are very intense,
2. Faint ordinary Fe II lines can be detected,
3. With the exception of a blend of ordinary and forbidden Fe II lines at 4355, and on one plate a faint emission at 4246, none of the strong forbidden lines is found.

A fourth plate taken in 1895 shows a spectrum much more like the emission spectrum found at present. There is still a continuous background with some absorption lines, but it is much fainter than in 1892-1893; the emission spectrum however is prominent. The three Balmer lines are still the strongest lines, but more than twenty other emission lines, due to ordinary *and forbidden Fe II*, are clearly visible. The photographic light curve for η Carinae, determined by Miss Leavitt, shows that the magnitude dropped from 7.5 in 1892-1893 to 8.3 in 1895.

The Harvard spectra after 1900 show the usual emission spectrum with perhaps a faint continuous background. The intensities of the Balmer lines and the strong ordinary and forbidden lines of Fe II are of the same order. The magnitude of the star has remained practically constant since 1895.

We conclude that *decreasing* intensity of the absorption spectrum is accompanied by *strengthening* of the ordinary Fe II lines relative to the Balmer lines and by *appearance* of very strong forbidden Fe II lines.

COLOR INDICES FOR SEVEN LONG-PERIOD VARIABLES.

By Leon Campbell and Cecilia H. Payne.

The changes of color with phase for seven long-period variables are derived by comparing the mean visual light curves (based chiefly on observations by the A.A.V.S.O.) with mean photographic light curves derived from Harvard plates. The color curves differ considerably for different stars.

Maxima that are unusually bright visually tend also to be bright photographically—an indication that maxima of unusual brightness are abnormal in luminosity rather than color.

The minima of S Pavonis are found to vary in depth, and a period of five thousand days, with three observed maxima, is suspected for this variability.

The material is published in *Harvard Bulletin* 873.

OMICRON CETI: PHOTOGRAPHIC LIGHT CURVE AND SPECTROSCOPIC NOTES.

By Annie J. Cannon.

The principal part of this paper is published in *Harvard Bulletin*, No. 872, under the title, "Photographic Light Curve and Color of Mira Ceti."

The investigation was based upon unpublished observations of the brightness of Mira on 1200 Harvard photographs taken between 1888 and 1918. The chief results were the derivation of dates for 28 maxima, 27 minima, and the formation of a mean photographic light curve. A comparison with a visual curve formed from Wendell's photometric observations, gave a color curve, which shows that the largest color index, +2 magnitudes, occurred on the rise to maximum.

Spectroscopic notes referred to a few facts derived from a preliminary examination of numerous Harvard spectra, photographed between 1885 and 1907.

Bright Hβ appeared only at the brighter maxima. Its greatest brilliancy was in December, 1906. Hγ was never observed to be brighter than Hδ.

The descending side of the curve after the maximum of October, 1898, is well covered by a series of plates taken with the 11-inch Draper telescope. On December 8, 1898, fifteen bright hydrogen lines, including all from Hγ to Hσ, except Hϵ, are visible. Peculiar changes in the structure of H and K are shown in this series of photographs. At first of normal, wide absorption, they became narrow and complex, and bright lines appeared on their sides of greater wave-length about two months after maximum.

Duplicity of the bright hydrogen line was apparent at the maxima of 1887 and 1888, when the fainter component was towards the violet, and of 1896, when it was towards the red.

THE SPECTROSCOPIC ORBIT OF THE ECLIPSING VARIABLE U CEPHEI.

By E. F. Carpenter.

During 1924-25 I was able to obtain at the Lick Observatory enough spectrograms of the eclipsing variable U Cephei, Type A0(primary), K0, to supplement its photometric orbit with a spectroscopic study. The character of the spectrum is not encouraging, only the four hydrogen lines of the primary star from Hβ to Hϵ, wide and diffuse, showing on my plates, but fortunately the range in velocity is rather large. The photometric observations worked up by Baker and by Dugan indicate consistently two ellipsoidal stars moving in a circular orbit, a shallow secondary minimum (0.1 mag.) appearing very close to a phase of one-half the period, though Shapley, on the basis of Wendell's observations,

suggests that the secondary minimum may occur as much as two hours after mid-phase.

Thirty-one spectrograms, combined with the velocity of the secondary star a primary minimum, kindly furnished by Joy, yielded, after least-squares correction, the following elements:

$$\begin{aligned} P &= 2^d.4929507 \\ e &= 0.474 \pm 0.022 \\ \omega &= 25°.0 \pm 3°.3 \\ \gamma &= -6.0 \text{ km per sec} \pm 3.7 \\ K &= 109.9 \text{ km per sec} \pm 3.1 \\ T &= 2423966.644 \pm 0.014 \\ a \sin i &= 3{,}320{,}000 \text{ km.} \\ m_1^3 \sin^3 i/(m+m_1)^2 &= 0.235 \end{aligned}$$

On any reasonable assumption for the mass of the secondary star, its velocity at primary eclipse should differ from that of the primary star by less than the probable error of one of my plates. Its inclusion in the solution, therefore, seemed justified, since, on account of the star's faintness near primary minimum, no other velocities were available near that phase. While the spectroscopic normal places are mutually consistent, the computed times of superior and inferior conjunction are 4 and 12 hours later, respectively, than the observed primary and secondary minimum. The discrepancy at primary eclipse may possibly be laid to reasonably small errors in the spectroscopic orbit, though efforts to remove them are not encouraging, but a discrepancy at secondary eclipse must be expected from the shape and orientation of the orbit.

Since the photometric observations of Baker and Dugan were centered about 1915.5 while the spectrograms were taken near 1924.5, it may be suggested that we have here an unusually highly elliptical orbit, with advancing periastron, having its major axis directed towards the earth in 1915 and shifted to $\omega = 25°$ in 1924. It remains to be seen whether this hypothesis can be fitted to the light curve, but such an orbital rotation is to be expected on dynamical principles in the case of elliptical stars moving in such a highly eccentric orbit, and, furthermore, the variation in the period of the star described by Mrs. Shapley and observed further by Leon Campbell may be a portion of the well-known oscillation of period associated with such a rotation.

I am indebted to Mrs. Carpenter for much assistance in the measurement and reduction of my plates. A more deailed paper will appear later.

SOME INSTRUMENTAL AIDS.

By H. D. Curtis.

a) A new type of comparator.

b) A set of permanent parallax sectors.

c) The Burns computing attachment for comparators.

d) The Allegheny Observatory instrument shop.

(Published as Vol. VIII, No. 2, of the *Publications of the Allegheny Observatory*.)

COLOR INDICES OF LONG-PERIOD VARIABLES.

By B. P. Gerasimovič and Harlow Shapley.

The colors of twenty-eight variables of long period were determined from a comparison of visual observations (mainly made by members of the A.A.V.S.O.) with concurrent photographic observations on Harvard plates. For the determinations of the mean color indices, an average of twelve different maxima were observed for each star (cf. *H.B.* 872). The observations were confined to maximum light, except for six of the stars which were also measured at minimum. In a succeeding note, Campbell and Miss Payne examine the colors of seven such variables throughout their periods.

The mean color index at maximum for long-period variables of spectral class M is +1.35, with no dependence on length of period. The average color index at minimum is +1.1, but the observations in minimum light are difficult and not very dependable.

The mean color index at maximum for seven stars of spectral class Se is +1.99, and again there is no noticeable dependence of color on length of period.

The colors of long-period Class-N stars at maxima depend upon spectral class and also on length of period, being much redder for the longer periods and for the later spectral subdivisions. In the mean the color index at maximum is nearly four magnitudes for Class-N stars.

The color index of S Camelopardalis, the only Class-R star in the list, is +2.9, based on measures of four maxima.

A STUDY OF THE VARIATION IN WAVE-LENGTH OF INDIVIDUAL LINES WITH SPECTRAL CLASS FROM F TO K.

By M. Alberta Hawes.

This paper gives the results of measurement of 109 spectrograms taken at Ann Arbor, Michigan. The stars were selected so as to include spectra covering evenly the range of spectral variation of the brighter Cepheids.

The change in intensity of the components of the lines or blends from class to class was studied from curves obtained by plotting residuals against spectral class. The curves showed variations in wave-length which were progressive with spectral class, the shift being in the direction of the relatively stronger component of the blend, and agreed with the change in intensity of the components in the sun and sun-spots.

Plates showing one hundred curves representing the one hundred lines measured are included in the results. They are especially applicable to the analysis of wave-length variations in Cepheids studied with the same spectrograph, and also to the classification of stellar spectra within the range considered.

UNCERTAINTY IN MASS-RATIO DERIVED FROM PHOTOGRAPHS WITH THE USE OF THE P.G.C. VALUE OF THE PROPER MOTION OF THE CENTER OF GRAVITY.

By Michel S. Kovalenko.

The method was suggested by Van Biesbroeck (*A.J.*, **29**, 173), and applied by him and others in the determination of mass-ratio of a few binaries. In all cases it was believed that the proper motion of the companion stars, relative to the P.G.C. system, would affect very little the value of the mass-ratio.

The measurements of a large number of regions of Boss stars, made during the last few years, show that the difference between the P.G.C. motions and the relative motions is 0″.02 or more in almost 30% of the regions, reaching 0″.07 and even 0″.09 in exceptional cases, the parallactic motion being only a small part of it.

How such a possible motion of the comparison stars as 0″.031 may change the value of the mass-ratio can be demonstrated by the measurements of the plates of 70 Ophiuchi, taken in 1914, 1915, 1920, and 1928 at the Sproul Observatory. The mass of the component A, when $A + B = 1$, was derived by this method for the intervals of 6, 8, 13, and 14 years. The P.G.C. value of the proper motion of the center of gravity is +0″.253. The resulting values of A are:

.54, .49, .52, and .52 respectively.

With the relative proper motion of the center of gravity, +0″.222, derived from the photographs, the values of A are:

.68, .71, .70, and .69 respectively.

This shows that the length of the intervals and the quality of the plates affect the second decimal, while the neglected proper motion of the comparison stars may often affect the first decimal. For the mass-ratio B : A the corresponding values are: .92 and .44, and the discrepancy is even more pronounced.

ALLEGHENY AND McCORMICK PARALLAXES COMPARED WITH SPECTROSCOPIC.

By S. A. Mitchell.

OCCURRENCE OF GERMANIUM AND ARSENIC IN METEORITES.

By Jacob Papish and Xaida M. Hanford.

In the spring of 1929 a grant from the Heckscher Foundation for the Advancement of Research was made to S. L. Boothroyd and Jacob Papish for the purpose of investigating the occurrence of the rare elements in meteorites.

Active work on this was begun by the autohrs in October, 1929, and at the present writing, December 28, 1929, spectroscopic evidence has

been obtained of the occurrence of germanium in six different meteorites. Judging from the number and intensity of the spectral lines, the germanium in these meteorites is present in traces. Germanium and arsenic have been chemically extracted from the Toluca and Welland siderites.

CEPHEID SPECTRA AND THE c-CHARACTERISTIC.

By Cecilia H. Payne.

The discussion of Cepheid spectra is published jointly with Dr. Shapley in *Harvard Bulletin* 872.

THE MASS-DENSITY RELATION.

By Eugene W. Pike.

A plot of the logarithms of the densities against the logarithms of the masses of almost all the stars for which reliable data exist shows the following noteworthy features:

(a) The plotted points group themselves into three narrow bands, corresponding to the main and giant sequences, and the secondary stars of eclipsing binaries of the low-temperature secondary type.

(b) The width of these bands is of the order of a factor of ten in the densities, much greater than the probable error, so that the dispersion is apparently real.

(c) The points are grouped according to mass, showing concentrations at five times, two and one-half times, and eight-tenths the sun's mass.

(d) The main sequence consists of two nearly straight lines joining at a slight angle at the point where the giant sequence joins it. The approximate equations of the center line of the band are:

$$m < 4\odot\ ;\ \rho = m^{-7/4} \qquad m > 4\odot\ ;\ \rho = 0.35\, m^{-1}.$$

This line is bent sharply downward at the high mass end to pass through the star HD 1337.

(e) For the four eclipsing binaries of the low-temperature secondary type for which masses and dimensions are accurately known, the density-ratios of the components are shown to be a constant power of the respective mass-ratios, this power being about 3/2.

(f) Several visual binaries and both components of the eclipsing star U Pegasi are shown to belong to the third sequence of paragraph (a), which lies parallel to and below the main sequence by a factor of twenty in the density.

An improved method of computing the surface temperatures of the secondary stars of eclipsing binaries was suggested, involving successive approximations to take account of the variation in visual efficiency of black-body radiation with temperature.

PHOTOGRAPHIC MEASURES OF CLOSE DOUBLE STARS.

By Dirk Reuyl.

There are several factors which will affect the distance of a close pair, of which the two most important are the turbidity action and the so-called Kostinsky effect, the former causing an apparent attraction, the latter a repulsion.

According to Ross' results the attraction due to turbidity may amount to as much as $-0^{mm}.015$, whereas the repulsion due to the Kostinsky effect in one of his experiments amounts to $+0^{mm}.015$.

Plates were taken with the 26-inch McCormick refractor on twenty doubles, most of them having distances $<2''.4$ ($1^{mm} = 20''.8$), and components of nearly equal magnitude.

On the Gaertner machine 115 images were measured in distance only. A magnifying power of 30 was used.

The measured distances were compared with micrometer measures. Plotting these against the time, a smooth curve was drawn, from which the distance for the epoch of the photographic observation was read.

The following results were obtained, in which ρ_m and ρ_p denote micrometric and photographic determinations respectively:

ρ_m	$\rho_p - \rho_m$	No. of Images
$1''.5 - 2''.4$	$-0''.10$	94
$>2''.4$	$+0''.01$	21

$1\text{ mm} = 20''.8$

For a comparison, Hertzsprung's measures during the years 1914-1919 with the 50 centimeter Potsdam refractor were treated in the same way, with the following results:

ρ_m	$\rho_p - \rho_m$	No. of Doubles
$1''.0 - 2''.0$	$-0''.09$	19
$>2''.0$	$+0''.02$	30

$1\text{ mm} = 16''.4$

Combining: $\rho_p - \rho_m = -0^{mm}.005 \pm 0^{mm}.001$ (p.e.) for $\rho_m < {}^{mm}.13$.

The results were derived from all images, under-, normal-, and over-exposed. Thus the value $-0^{mm}.005$ is an average. For the weak exposures a difference of as much as $-0^{mm}.010$ was found which corresponds to $-0''.2$ on the McCormick plates. With increase of exposure time the Kostinsky repulsion increases and may neutralize the attraction due to turbidity, with the result that there may be a certain exposure time for which the above mentioned attracting and repulsing forces will just balance each other and reproduce the true distance on the plate.

PHOTOGRAPHIC LIGHT CURVES OF FORTY CEPHEID VARIABLES.

By L. V. Robinson.

By making use of information which may be had from the photographic plates taken at Harvard during the last thirty odd years, an investigation has been under way since June to obtain light curves for all Cepheid variables brighter than 12.0 at minimum. It is hoped that information additional to what has already been found by Hertzsprung as to the relation between period and form of light curve will be secured. Thus far more than 40 light curves have been obtained, each based on more than 200 single estimates.

For periods longer than 10 days the results not only confirm the Hertzsprung relation, but indicate very clearly the presence of humps in the descending branches, which Hertzsprung, in view of the relatively small number of reliable light curves, felt impelled to smooth out. For periods shorter than 10 days the relation is not so well marked, thus accounting for the suspicions raised by some that such variables do not constitute a homogeneous class. This is especially true of 8-day periods, but the anomalies here observed are without doubt explained by the behavior of a secondary wave which seems to underlie the great differences observed in form of light curve with small differences in period. The light curves of a large number of variables of shorter period seem to be undergoing rapid changes, thereby explaining the observed anomalies. The great prominence assumed by the secondary wave at periods of about 7.5 days is apparently related to the fall in frequency distribution for periods between 8.0 and 9.5 days.

On the basis of the change in form of light curve observed, beginning with periods of about 9 days, it is proposed to classify Cepheids into at least three classes: (A) cluster-type variables, (B) typical δ Cephei variables with periods less than 9 days, and (C) variables with periods longer than 9 days. A possible fourth subclass would consist of variables with periods longer than about 30 days, but additional investigations are awaited. This classification agrees very approximately with that already made by Ludendorff.

It is shown also that for subclass (C) there exists a linear relation between $(M - m)/P$ and the logarithm of the period, and that, were it possible to extend the relation, $(M - m)/P$ would assume the limiting values of unity and zero at periods of about 1.6 and 56 days, respectively, agreeing closely with the shortest- and longest-period Cepheids, if the cluster type variables are for the moment excluded. This relation can also be extended into subclass (B), to periods of about 7 days, if values of $(M - m)/P$ are reckoned from the secondary maximum. The value $(M - m)/P = \frac{1}{2}$ apparently characterizes the line of demarcation between subclasses (B) and (C).

ON THE FORMATION OF ABSORPTION LINES IN STELLAR SPECTRA.

By S. Rosseland.

The principal purpose of the paper was to consider the strict consequences of the assumption of local thermodynamic equilibrium for the absorption lines formed in a stellar atmosphere, and to consider the relative importance of true coherent scattering, and true absorption and emission (involving quantum transitions) in the growth of a line. It was concluded that the two processes were of about equal importance, and a simple formula for the contour of an absorption line, based on this fact, was given.

VARIABLE STARS IN THE LARGE MAGELLANIC CLOUD.

By Harlow Shapley.

The paper reports studies of variable stars, of the Cepheid class, discovered in the Large Magellanic Cloud by Miss Leavitt. Periods have now been determined for more than fifty variables and a period-luminosity curve has been derived. The scattering about the curve is considerable. It is to be attributed to observational errors, thickness of the Cloud, photographic effects due to the irregular crowding of star images, and possibly to obscuring nebulosity in the Cloud. For the distance of the Cloud, the new work on the variables yields a value of 86,000 light years. The corresponding linear diameter is about eleven thousand light years, which is of the same order as that of the brighter spiral nebulae.

Details of the study of the variables in the Large Magellanic Cloud will be printed in Harvard Observatory publications.

VARIABLE STARS IN GLOBULAR CLUSTERS.

By Harlow Shapley and Helen B. Sawyer.

Variable stars in globular clusters have been studied for forty years. The names most frequently associated with the work are Pickering, Common, Packer, Bailey, Shapley, Miss Davis, Miss Woods, Larink, and Baade.

Of the 93 clusters classed as globular (excluding those in the Magellanic Clouds) 42 have now been rather thoroughly examined for variables. About 970 variables have been found. A little less than half of these, or 466, have known periods, of which, however, four clusters contribute 355. The variables appear to be mostly cluster-type Cepheids; but there are also 19 classical Cepheids and long-period variables, and one nova, which appeared in Messier 80 in 1860. No eclipsing binaries have been found; but in most clusters there has been little chance for their discovery.

Ten of the clusters have more than 25 variables each, and 17 have less

than 5. Three clusters have no variables. The number of variables in a cluster has no known correlation with other data for the cluster, except for a very slight tendency for the number of variables to decrease with approach to the galactic plane. The numbers of variables in clusters of about the same type and equally well examined, range from 166 in Messier 3 to only 3 in Messier 13.

The mean median magnitude of the cluster-type variables is usually about 1.2 magnitudes fainter than the mean of the 25 brightest stars, as determined for 19 clusters. There is, however, a peculiar and rare type of cluster, in which the variables are only 0.5 magnitude fainter than the bright stars.

PRELIMINARY REPORT ON THE PROBABILITY OF CLEAR SKY FOR THE 1932 TOTAL ECLIPSE OF THE SUN.

By Frederick Slocum.

The eclipse of August 31, 1932, begins at sunrise north of Siberia, passes within about 5° of the north pole, comes down across Hudson Bay, Province of Quebec, northern Vermont, New Hampshire, southwestern Maine, the eastern projection of Massachusetts, and ends at sunset in the middle of the Atlantic Ocean. Observations will be limited chiefly to the region between Hudson Bay and the Maine coast. Within these limits the duration of totality will vary from 105 seconds at the southern edge of Hudson Bay to 98 seconds on the Maine coast. Within the same limits the local time of totality ranges from $2^h\ 50^m$ to $3^h\ 50^m$ P.M. and the altitude of the sun from 33° to 29°.

Weather observations have been received from about 100 stations, scattered all the way from Fort George on Hudson Bay to Provincetown on the tip of Cape Cod. The average percentage of clear sky for 3:30 P.M. from August 16 to September 16 for the five years 1925-1929, is: Hudson Bay, 40%; Province of Quebec, 52%; Northern New Hampshire and Vermont, 48%; Summit of Mt. Washington, 39%; Maine Inland Stations, 58%; Maine Coast, 49%; Islands off the Maine Coast, 51%; Cape Ann, 53%; Cape Cod, 60%.

For a full report see April (1930) issue of Popular Astronomy.

A FURTHER STUDY OF THE VARIATION IN LATITUDE WITH THE MOON'S POSITION.

By H. T. Stetson and Margaret Olmsted.

At the Amherst meeting of the Society in 1928 a paper was presented and a series of graphs shown exhibiting the results of an extensive study of the Gaithersburg latitude observations.

The removal of the photographic zenith tube to Washington has given an independent set of data. Dr. Littell has placed in our hands records for 1920-1927.

Their analysis shows the same sort of variation dependent upon the

moon's hour angle and declination, but with some outstanding differences.

The Washington observations, however, give more nearly a sine curve. When examined from H.A. 18^h to 18^h two maxima occur, one at 22^h, the other at about 11^h. A sharp minimum occurs new H.A. 6^h. The extraordinarily large amplitude of the curve as compared with the probable error of single points on the curve gives assurance of the reality of the correlation.

The curve showing the correlation of altitude with latitude exhibits a range of about $0''.04$ or about half that shown by the Gaithersburg series. Maxima occur at altitude $-45°$ and $+40°$. Another maximum at $+65°$ is the outstanding discrepancy when compared with the Gaithersburg series.

The azimuth curve for the Washington observations follows again very approximately a sine curve, the maximum values for latitude occurring when the moon is due south of the station. The minimum occurs when the moon is a little north at lower culmination, but two secondary minima occur each 30° either side of the east point.

Some further researches have been made on the possible causes of this latitude variation with the lunar altitude. The two most plausible sources appear in a periodic refraction due to a lunar tide in the earth's atmosphere and an actual deflection of gravity by an earth tide.

There appears to be more supporting evidence for an earth-tide theory than perhaps any other hypothesis that has been suggested.

SOME RESTRICTIONS ON THE APPLICATION OF THE ROCKET PRINCIPLE TO INTERPLANETARY TRAVEL.

By J. Q. Stewart.

Mathematical discussion of the momenta and energies required to be developed by rockets, (a) in a uniform gravitational field, (b) in an inverse square gravitational field. In order that a rocket, firing continuously, may carry to a certain height a fair fraction of its initial mass, the speed of projection of material downward must be at least of the order of the initial upward speed which would be required in a projectile rising to the same height. Until fuels are available which release per gram of mass many times more energy than present fuels can, it will be impracticable to send rockets to very great heights. It seems reasonable to anticipate that such fuels will become available in the indefinite future. The equations of this paper will be published in full.

POSSIBLE REPULSION OF PARTICLES NEAR STARS DUE TO THE INFLUENCE OF NON-ISOTROPIC EVAPORATION.

By J. Q. Stewart.

When a particle near the sun is evaporating, there may be a reaction on its sunward surface due to the momentum of the molecules of the gas formed there as these molecules are projected away. Calcula-

tion indicates that this effect may overbalance gravity for objects less than a few millimeters in diameter. Detailed study would be required to show whether this phenomenon is actually observed in astrophysics. Perhaps the material often ejected from the nuclei of comets with a velocity of several kilometers a second may owe part of its speed to such a cause. It is impossible, however, that particles should build up an escape velocity from the sun due to this "rocket" effect of non-isotropic evaporation, as they would be entirely vaporized before they acquired a speed so far exceeding that of the ejected molecules.

NOTE ON THE ECLIPSING VARIABLE, DELTA ORIONIS.

By N. Wyman Storer.

Observations made with the photoelectric photometer of the Lick Observatory during the autumn of 1926 indicate a change in the primary minimum of the light curve of Delta Orionis. The change, which might be interpreted either as a periodic variation in the period of the binary or as a periodic broadening of the minimum, gave evidence of going through its cycle in approximately four periods of the binary, that is, in about 23 days. The complete paper is to appear in an early number of the *Publications of the Astronomical Society of the Pacific.*

NOTE ON THE SPECTRUM OF 7 ϵ AURIGAE.

By O. Struve and C. T. Elvey.

Spectrographic observations of this star, made at the Yerkes Observatory, show that many absorption lines were unsymmetrical during the eclipse of 1928-1930. During the first part of the eclipse the lines were sharp on the red side; in the middle they were nearly symmetrical; and in the latter part of the eclipse they were sharp on the violet side. This phenomenon is shown by most of the stronger lines, e.g., Ti^+ 4468, Ti^+ 4444, Ti^+ 4501, etc. The line Mg^+ 4481 remained symmetrical throughout the whole series of observations.

The radial velocities derived from the unsymmetrical lines are too high for the first half of the eclipse and too low for the latter part. The symmetrical lines give more reliable velocities.

The absorption lines are strengthened during the time of eclipse. This seems to indicate that the absorbing layer is deeper and that the number of effective atoms is greater during the time of the eclipse than outside of it. The contour of the line Hβ agrees well with Unsöld's theoretical formula. The center is practically black, except for a very narrow central emission line. The absence of wide wings suggests that Stark effect is not present and confirms the giant character of this star.

All absorption lines share in the oscillations which have a period of about 110 days. These are probably related to the fluctuations in light discovered by Stebbins, Frl. Güssow, and McLaughlin.

Our observations confirm the variation in velocity with a period of 27.1 years, discovered by Ludendorff.

INTERIM REPORT ON THE SURVEY FOR VARIABLE STARS IN THE MILKY WAY.

By Henrietta H. Swope.

Six observers have been working on eight different fields on the systematic survey for variable stars in the Milky Way during the past year. The distribution of the fields, the numbers of known and new variables and the observers are noted in Table I. Fields 170, 171, and 172 have not yet been completely examined. MWF 169 has been studied by A. L. Bunting, E. B. Florance, and C. C. Sherman.

For the fields nearest completion the distribution of the variable stars among the various types is shown in Table II, which also includes two fields, MWF 173 and 185, that have already been published.

TABLE I.

Milky Way Variables Under Observation, December, 1929.

MWF	Galactic Position λ	β	—Variables— Published	New	Observer
167	277°.5	+7°.5	39	120	D. Hoffleit
169	277.5	−7.5	5	130	.....
170	285.	+7.5	8		
171	285	±0.0	10	35	W. F. H. Waterfield
172	285	−7.5	4		
176	300	+7.5	4	85	I. W. Caldwell
184	315	−7.5	15	315	C. D. Boyd
187	322.5	−7.5	60	680	H. H. Swope
		Total	145	1365	

TABLE II.

Types of Variables, in Percentages.

MWF	Long	Cluster Type	Short	Eclipsing	Undetermined
			%		
167	32	20	13	19	16
169	31	18	18	13	20
173	35	26	11	13	15
176	63	9	9	0	19
184	36	13	34	4	13
185	41	29	16	2	12

The high percentage of long-period variables in MWF 176 is probably an indication that the field has not yet been completely examined. There is a tendency for the cluster-type Cepheids to be proportionately more numerous towards the center of the Milky Way; the reverse is true for eclipsing variables. The stars listed as of short period are those for which the ranges are small and for which there is not enough material to determine the type. In MWF 184 there is still a large number in the short-period column because only a few plates are as yet available for discussion of periods. In the column of undetermined types are collected the irregular variables and those that are too faint or too close to companion stars for accurate estimates of magnitude.

(To be continued.)

PLANET NOTES FOR SEPTEMBER AND OCTOBER

By CLIFFORD E. SMITH.

The *Sun* will be moving southeast from the central part of Leo to the eastern part of Virgo. On September 23 the sun will cross the celestial equator, which marks, officially, the beginning of Fall. There will be a total eclipse of the sun on October 21, which will be invisible in the northern hemisphere. The eclipse will begin at about latitude five degrees north and longitude 145 degrees east of Greenwich, which is approximately north of Australia, and it will move southeast, ending near the southernmost tip of South America. The position of the sun on September 1, October 1, and October 31 will be respectively: R.A. $10^h\ 38^m$, Decl. $+8°\ 38'$; R.A. $12^h\ 26^m$, Decl. $-2°\ 49'$; R.A. $14^h\ 18^m$, Decl. $-13°\ 48'$.

The phases of the *Moon* will occur as follows:

Full Moon	Sept.	7 at	9 P.M.	C.S.T.
Last Quarter		15 "	3 P.M.	"
New Moon		22 "	6 A.M.	"
First Quarter		29 "	9 A.M.	"
Full Moon	Oct.	7 at	1 P.M.	C.S.T.
Last Quarter		14 "	11 P.M.	"
New Moon		21 "	4 P.M.	"
First Quarter		29 "	3 A.M.	"

The moon will be at apogee on September 5, October 3, and October 31, and it will be at perigee on September 21 and October 19. There will be a partial eclipse of the moon on October 7 which will be visible in Asia, Australia, the Indian Ocean, Europe, and Africa, but not in the United States.

Mercury will be in Virgo. From September 8 to September 30 its apparent motion will be retrograde or westerly, and during the rest of the period it will be moving apparently eastward. It will move from the western to the eastern part of the constellation, and its apparent magnitude will be about plus one. At the beginning of September it will set about an hour and a half after the sun, but it will approach inferior conjunction rapidly which will occur on September 21. Greatest elongation west will occur on October 7 and at that time it will rise about an hour before the sun.

Venus will be moving with an apparent easterly motion from the central part of Virgo, across Libra, to the central part of Scorpio. At the end of October it will be about two degrees from the bright star Antares. Venus will be a very brilliant evening star in the west. Its apparent brightness will be about magnitude minus four (about fifteen times brighter than the bright star Sirius), and it will set about three hours after the sun. It will be at greatest elongation east on September 13, at aphelion on September 15, in conjunction with the moon on September 25, at greatest brilliancy (mag. —4.3) on October 18, and again in conjunction with the moon on October 24.

Jupiter will be a brilliant star in eastern Gemini during this period. Its apparent magnitude will be about minus two or about four times as bright as Sirius. During October it will be near the meridian at sunrise since quadrature west of the sun occurs on October 13. Sirius will be near the meridian at the same time but it will be about thirty degrees nearer the horizon. On September 17 and on

October 15 Jupiter will be in conjunction with the moon, and on September 27 it will be in conjunction with Mars. Its apparent motion will be direct.

Saturn will be in western Sagittarius, and it will appear as an evening star, approximately in the south at sunset. Its apparent magnitude will be about plus one or about one hundred times fainter than Venus which is an evening star also during this period. Its apparent motion will be retrograde until September 9, thereafter direct. On September 2, September 29, and on October 27 Jupiter will be in conjunction with the moon, and on September 29 it will be also in quadrature east of the sun.

Uranus will be in southern Pisces and it will be approximately on the meridian during the middle of the period since opposition with the sun occurs on October 7. Its apparent motion during this period will be retrograde. On September 10 and on October 7 it will be in conjunction with the moon.

Neptune will be near the sun in apparent position, conjunction with the sun occurring late in August.

Occultations Visible at Washington

[From the *American Ephemeris.*]

Date 1930		Star	Mag.	IMMERSION Washington C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Washington C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
Sept.	1	C.D.—28°1+	6.4	17 36	—2.2	+1.1	80	19 4	—2.1	—0.3	293
	2	183 B.Sgr	6.2	18 3	—1.3	—0.3	136	19 3	—2.5	+1.8	221
	4	86 B.Cap.	6.2	18 47	—1.4	+0.4	123	19 41	—1.8	+2.6	204
	5	143 B.Cap.	6.1	20 5	—2.0	+1.0	103	21 11	—1.4	+2.2	203
	6	56 Aqr	6.1	21 5	—1.8	+1.7	64	22 31	—1.7	+1.4	228
	7	ψ^1 Aqr	4.5	22 18	—1.9	+1.5	67	23 41	—1.3	+1.7	214
	8	27 Psc	5.1	22 0	—1.6	+1.8	70	23 16	—1.1	+2.1	211
	9	29 Psc	5.1	0 49	...	...	105	1 36	...	...	171
	12	ρ Ari	5.6	20 18	+0.6	+1.5	52	21 9	+0.2	+1.3	256
	13	133 B.Tau	5.9	20 54	+0.5	+1.0	90	21 41	+0.5	+1.6	226
	14	33 Tau	6.0	0 15	—0.2	+2.1	48	1 20	—1.1	+1.4	257
	14	36 Tau	5.6	5 1	—1.4	+3.1	26	6 3	—2.3	—2.3	292
	15	136 Tau	4.6	23 38	+0.6	+1.6	55	0 27	—0.2	+0.9	280
	18	ω Cnc	6.1	0 9	+0.8	+1.1	74	0 55	+0.2	+0.5	293
	18	4 Cnc	6.2	0 33	—0.1	—0.2	141	1 6	+0.9	+2.0	226
	26	40 B.Sco	5.4	17 16	—1.8	—1.5	130	18 30	—1.5	—1.0	262
	28	210 B.Sco	5.8	21 0	—0.3	+0.1	42	21 55	—1.3	—2.4	303
Oct.	2	35 Cap	6.0	18 53	...	...	123	19 35	...	...	181
	3	37 Cap	5.7	0 50	...	...	136	1 7	...	...	162
	7	e Psc	5.6	18 38	—0.2	+1.7	72	19 39	—0.4	+2.0	223
	7	88 Psc	6.2	23 29	—1.4	+1.8	44	0 52	—1.7	+1.1	233
	8	54 Cet	6.0	17 22	+0.5	+1.6	53	18 14	+0.2	+1.4	253
	8	26 B.Ari	6.0	22 15	—1.2	+1.9	60	23 31	—1.2	+2.0	222
	9	π Ari	5.2	23 1	...	...	116	23 37	...	...	174
	24	a Sco	1.3	15 51	—1.9	—0.6	86	17 10	—1.6	—1.6	296
	24	116 B.Sco	6.2	17 2	—1.4	—1.0	91	18 16	—1.1	—1.6	284
	30	29 Aqr	6.5	23 0	+0.5	+2.0	6	23 44	—1.3	—2.5	286

The quantities in the columns a and b are given for the purpose of making these predictions useful for any place within 200 or 300 miles of Washington. The procedure is as follows: Subtract the longitude of Washington (77°1) from the longitude of the place in question; multiply the result, taking the signs into ac-

count, by the quantity under a for the star to be observed; similarly, with the latitude (38°9) using b; apply the sum of the products, with its proper sign, to the Washington C.T., and obtain the predicted Washington Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to add 8.3 minutes to Washington Civil Time.

The Trans-Neptunian Planet. — While this designation has served thus far to identify the new planet recently discovered at the Lowell Observatory, it is obvious that the planet could not permanently be referred to in this way. Consequently the name PLUTO has been proposed by the discoverers as the one most appropriate among the many names that have been suggested. An *Observation Circular*, issued by the Lowell Observatory on May 1, 1930, after a discussion of the elements of the orbit, published in the May issue (p. 296), concludes as follows:

> Concerning the nature of this object it is of record that the longest exposures with the reflector by Lampland and the repeated visual observations with the refractor by E. C. Slipher and the writer have revealed no cometary features about the object. Besides, comets have been observed at nothing like this distance from the sun. As for asteroids, Planet X would outshine 100-fold the largest of the asteroids, Ceres, (diameter 480 miles) if removed to the same distance. Finally the orbit is no sufficient ground upon which to venture a decision as to the nature of such an object. Here is suggested an obvious analogy between the Sun's increased family of planets and the satellite system of Jupiter whose newer satellites have orbits at considerable variance with these of the older satellites, just as the orbit of Planet X differs from those of its older brothers. It is pertinent to draw attention to the fact that Planet X has like the older planets direct motion about the sun.
>
> This then appears to be a Trans-Neptunian, non-cometary, non-asteroidal body that fits substantially Lowell's predicted longitude, inclination and distance for his Planet X. Lowell considered his predicted data as only approximate, and a one to one correspondence between forecast and find would not be expected by those familiar with the problem. As he himself said in his Trans-Neptunian Planet Memoir: "Analytics thought to promise the precision of a rifle and finds it must rely upon the promiscuity of a shot gun." This remarkable Trans-Neptunian planetary body has been found as a direct result of Lowell's work, planning and convictions and there appears present justification for referring to it as his Planet X.
>
> It seems time now that this body should be given a name of its own. Many names have been suggested and among them Minerva and Pluto have been very popular. But, as Minerva has long been used for one of the asteroids it is really not available for this object. However, Pluto seems very appropriate and we are proposing to the American Astronomical Society and to the Royal Astronomical Society, that this name be given it. As far as we know Pluto was first suggested by Miss Venetia Burney, aged 11, of Oxford, England.* As a fitting symbol to go with the name we have suggested PL,† easily remembered because the first two letters of the name and not to be confused with the symbols of the other planets.
>
> Flagstaff, Arizona, May 1, 1930. V. M. SLIPHER.

*Kindly cabled by Prof. H. H. Turner.

†These letters are joined into a single symbol in a way which cannot be indicated by ordinary type. This name was suggested also by Professor William H. Pickering in the May issue, p. 296.—ED.

Earlier records of this planet are being found at various places. For example:

PLUTO.—A telegram received from Professor F. H. Seares states that images of Pluto have been found by Nicholson on four plates taken by Humason on December 28, 29, 30, 1919. The mean of the four positions, re-

duced to the beginning of 1930, is as follows:

	R.A. 1930.0	Dec. 1930.0
	h m s	° ′ ″
1919 December 29.0667	6 29 3.8	+ 19 21 56

The daily motion is given as $\Delta\alpha = -5^s.14$, $\Delta\delta = +6''.8$.

HARLOW SHAPLEY.

Harvard College Observatory Announcement Card 133.
June 16, 1930.

Note on South African Photographs of Pluto

The Trans-Neptunian planet was photographed with the Bruce 24-inch refractor on the following dates:

	h	m	
1930 March	18	5	42 (U.T.)
	19	5	55
	27	6	48
April	16	5	18
	18	5	15

The motion as shown by the plates taken on March 18, 19, and 27 was retrograde. The planet reached its stationary point about the first week in April and on April 16 and 18 the motion was direct, with a rate of approximately 25 seconds of arc per diem. In its eastward progression the planet is passing slightly north of Delta Geminorum.

The aspect of the planet on the photographic plates is purely stellar.

J. S. PARASKEVOPOULOS.

Boyden Station of the Harvard Observatory.
April 23, 1930.

VARIABLE STARS

Monthly Report of the American Association of Variable Star Observers for May and June, 1930

The meeting of the Association held at the Maria Mitchell Observatory at Nantucket, Massachusetts, in June really extended over three days, from Friday the 13th to Sunday the 15th. Some few enthusiasts arrived as early as Thursday and remained until Monday. While the attendance was not so large as at the meeting held in Washington, D. C., last year, cordiality and good fellowship reigned supreme. When numbers are small, there is a better chance to know the other fellow better. Miss Harwood acted the part of hostess with her usual finesse and charm, and left nothing undone to provide for the comfort and entertainment of members and guests.

President Alice H. Farnsworth handled the gavel at both Council and Business Meetings, and in the enforced absence of Secretary Olcott, the Recording Secretary acted in his stead. Reports of Committees indicated marked progress in the various lines of endeavor and that of the Chart Committee deserves especial mention. This included detailed lists of new and revised charts, of help to all observing members to whom copies have already been issued. Others may obtain copies by addressing Mr. D. B. Pickering, 171 South Burnett Street, East Orange, New Jersey, and enclosing 50 cents in stamps. The Chairman has given therein a short history of the activities of the Committee during the past ten years.

Variable Star Observations Received During May and June, 1930.

April 0 = J.D. 2426067; May 0 = J.D. 2426097; June 0 = J.D. 2426128.

J.D.Est.Obs.

X And
001046
092 9.9 Lj
094 10.1 Lj
102 9.1 Lj
116 9.0 Lj
125 9.2 Lj
127 9.3 Lj

T And
001726
104 8.4 Pt
130 9.2 Pt

T Cas
001755
099 11.9 L
104 12.0 Pt
124 12.0 Jo
130 11.8 Pt
130 11.8 Jo

R And
001838
104 13.0 Pt
127[11.1 Fd

S Tuc
001862
039 10.2 En
055 10.4 Sm
060 10.7 Ht
069 11.5 Bl
079 12.7 Bl
082 12.3 Dr
094 13.1 Bl
111[12.4 Bl

Y Cep
003179
081 14.0 L
124 11.5 Sf
041 10.3 Sf

U Cas
004047
077 8.3 L
099 8.7 L
104 8.5 Pt
130 10.9 Pt

RV Cas
004746a
104 11.7 Pt
130 12.8 Pt

— Cas
004746b
104 10.6 Pt
130 10.6 Pt

W Cas
004958
081 10.0 Jo
082 10.3 Jo
087 10.5 Jo
095 10.6 Jo
100 11.1 Fd

W Cas
004958
104 10.5 Pt
121 11.9 Fd
124 11.7 Jo
130 12.0 Jo
148 8.8 Pt

U Tuc
005475
039[12.9 En
055[12.9 Sm
060[12.9 Ht
067[12.9 Ht
072[12.9 Ht
082 13.2 Dr
083 12.7 Ht
087 13.1 Dr
088 12.6 Ht
093 12.6 Ht
094 12.4 Bl
111 11.1 Bl
117 10.6 Bl

U Scl
010630
069 10.0 Bl

S Cas
011272
064 9.5 Ch
081 8.8 Jo
087 8.7 Jo
095 8.7 Jo
105 8.9 Pt
118 9.0 Jo
127 8.8 Jo
130 9.2 Jo
130 8.8 Pt

RZ Per
012350
073 11.6 L

RU And
013238
073 12.0 L
130 10.8 Pt

013338

Y And
073 8.8 L
105 9.1 Pt
130 10.6 Pt

X Cas
014958
105 10.5 Pt
115 11.3 Bn
130 10.6 Pt
143 10.7 Bn

U Per
015254
130 9.9 Pt

W And
021143a
130 7.8 Pt

T Per
021258
081 8.7 Jo
087 8.5 Jo
090 8.7 Ah
093 8.5 Jo
096 8.6 Ah
105 8.5 Pt
130 8.2 Pt

o Cet
021403
039 8.8 En

S Per
021558
081 9.5 Jo
087 9.3 Jo
090 9.3 Ah
093 9.0 Jo
096 9.3 Ah
105 9.3 Pt
130 8.9 Pt

RR Per
022150
081 13.7 L

R For
022426
069 8.5 Bl
079 8.6 Bl

R Tri
023133
051 9.2 Ch

W Per
024356
081 10.8 Jo
087 10.6 Jo
093 10.3 Jo
105 10.5 Pt
130 10.6 Pt

R Hor
025050
039 6.1 En
044 6.1 Sm
051 5.9 Ht
056 5.8 Sm
060 5.6 Ht
067 5.6 Ht
067 5.5 En
069 5.6 Bl
072 5.4 Ht
072 6.1 Sm
079 5.8 Bl
082 5.9 Dr
083 5.4 Ht
088 5.8 Ht
093 5.8 Ht
094 5.9 Bl

R Hor
025050
111 6.8 Bl
117 6.8 Bl

T Hor
025751
039 11.3 En
056 10.8 Sm
060 10.8 Ht
067 10.2 En
067 9.9 Ht
069 9.7 Bl
072 9.7 Ht
079 9.1 Bl
082 9.3 Dr
083 9.1 Ht
088 8.1 Ht
093 7.9 Ht
094 7.8 Bl
111 8.4 Bl
117 8.9 Bl

U Ari
030514
073[12.6 L

Y Per
032043
063 9.0 Ch
086 8.7 BL
087 8.8 BL
130 10.2 Pt

R Per
032335
063 10.6 Ch
077 12.0 L

U Eri
034625
058 12.1 Sm
067 11.6 En
072 11.6 Sm
082 10.4 Dr

T Eri
035124
039 11.9 En
067 11.9 En
082 12.0 Dr

R Tau
042209
073 13.8 Nz
084[12.5 Nz

W Tau
042215
063 10.8 Ch
073 10.5 L
090 10.7 L

S Tau
^{z}N 6'E]+80
042309
073[14.3 Nz

T Cam
043065
077 12.0 L
090 10.6 L
109 9.7 L

RX Tau
043208
083[12.8 L

R Ret
043263
041 11.6 Sm
042 11.8 En
055 11.0 En
056 11.0 Sm
060 10.9 Ht
067 10.0 Ht
067 10.1 En
069 9.8 Bl
070 9.7 Dr
072 9.8 Sm
072 9.7 Ht
072 10.0 En
079 8.6 Bl
082 8.8 Dr
083 8.4 Ht
084 8.7 En
088 8.5 Ht
089 8.4 Dr
092 8.7 En
093 8.3 Ht
094 8.5 Bl
111 8.5 Bl
117 8.5 Bl

X Cam
043274
077 11.1 L
090 10.0 L
109 8.5 L

R Dor
043562
041 5.5 Sm
042 5.8 En
055 5.8 En
056 5.2 Sm
060 5.6 Ht
067 5.6 Ht
067 5.6 En
069 5.7 Bl
072 5.6 Ht
072 5.8 Sm
072 6.0 En
079 5.7 Bl
082 5.9 Dr
083 5.5 Ht
084 6.0 En
088 5.5 Ht
089 6.0 Dr
092 5.8 En
093 5.5 Ht

R Dor
043562
094 5.9 Bl
111 6.2 Bl
117 5.9 Bl

R Cae
043738
042[12.0 En
056[12.0 Sm
060[12.0 Ht
067[12.0 En
072[11.7 Sm
084[11.7 En
088[12.0 Ht
094[12.5 Bl
117[12.0 Bl

R Pic
044349
042 8.8 En
056 8.8 En
056 9.0 Sm
060 9.0 Ht
067 8.6 Ht
069 8.6 Bl
070 8.0 Dr
072 8.3 Ht
072 8.2 Sm
072 7.8 En
079 7.9 Bl
082 7.8 Dr
083 7.6 Ht
084 7.7 En
088 7.5 Ht
089 7.4 Dr
092 7.3 En
093 7.3 Ht
094 6.7 Bl
111 6.7 Bl
117 6.4 Bl

R Ori
045307
071[11.3 Ch
077 12.0 L

V Ori
050003
062 11.0 Ch
073 12.4 Nz
077 12.0 L
084 12.5 Nz
091 12.3 B

T Lep
050022
041 9.7 Sm
042 8.6 En
056 10.0 Sm
060 9.1 En
069 10.3 Bl
072 10.3 Sm
079 10.1 Bl

Variable Star Observations Received During May and June, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T Lep	T Col	AN Ori	SU Tau	U Ori	R Oct
050022	*051533*	*053005t*	054319	054920a	*055686*
084 10.7 En	070 10.2 Dr	097 11.5 L	080 9.6 Br	071 10.4 Ch	088 11.4 Ht
092 11.1 En	072 9.8 Ht	S Cam	081 9.6 Pt	081 11.0 Jo	088 11.0 En
094 10.5 Bl	072 10.1 Sm	053068	083 9.5 B	087 11.4 Jo	089 11.3 Dr
117 11.2 Bl	072 9.7 En	062 8.5 Ch	083 9.5 L	088 11.8 B	092 11.0 En
S Pic	079 9.5 Bl	086 8.8 BL	084 9.5 Br	089 10.6 Pt	093 11.4 Ht
050848	083 9.7 Ht	087 8.7 BL	088 9.5 L	093 11.6 Jo	094 11.5 Bl
042 12.2 En	084 8.9 En	089 9.0 Pt	089 9.8 Pt	095 11.3 Ch	111 11.1 Bl
056 11.7 Sm	088 9.5 Ht	091 8.8 BL	090 9.8 Pt	V Cam	117 11.1 Bl
060 11.9 En	089 9.2 Dr	093 8.9 BL	090 9.6 L	054974	X Aur
060 12.2 Ht	092 9.0 En	096 8.9 BL	093 9.6 L	082 12.5 B	060450
067 12.2 Ht	093 8.9 Ht	100 9.0 BL	093 9.8 Pt	083 12.5 L	063 9.3 Ch
069 11.9 Bl	094 8.5 Bl	103 9.1 BL	095 9.8 Ch	087 11.4 Sf	068 9.6 Lj
070 12.4 Dr	111 8.2 Bl	104 9.1 BL	097 9.5 L	089 11.3 Pt	071 8.8 Ch
072 12.2 Ht	117 7.7 Bl	105 8.9 BL	099 9.8 Pt	093 11.1 Sf	073 8.8 L
072 12.2 Sm	S Aur	106 8.9 BL	101 9.6 L	097 10.4 L	082 9.2 B
083 12.9 Ht	052034	122 9.3 BL	102 9.7 Pt	100 10.6 Sf	085 9.1 L
088 12.9 Ht	062 10.4 Ch	RR Tau	103 9.8 Pt	110 9.7 B	087 9.7 Sf
089 13.0 Dr	086 10.7 BL	053326	105 10.1 Pt	110 10.3 L	088 9.0 Sw
093 12.9 Ht	087 10.8 BL	069 11.9 L	106 10.0 Pt	122 10.5 Sf	089 9.2 Pt
094 12.5 Bl	089 10.1 Pt	072 12.6 L	S Col	Z Aur	091 9.1 Ch
117 13.2 Bl	093 10.9 BL	073 13.1 L	*054331*	055353	092 9.7 Lj
R Aur	096 11.0 BL	073 12.7 Nz	055[12.2 Sm	081 10.2 Pt	093 9.8 Sf
050953	100 11.1 BL	077 13.1 L	060[12.6 Ht	082 10.7 B	094 9.8 Lj
087 9.0 Jo	W Aur	078 12.6 L	065[12.2 En	086 10.2 Pt	097 9.8 Lj
096 8.7 Jo	052036	079 12.5 L	072[12.2 Sm	087 10.8 Jo	097 9.1 L
098 10.6 B	083 14.6 L	081 12.3 L	083[12.6 Ht	089 10.2 Pt	101 9.9 Lj
096 11.6 Ch	093 13.6 L	083 12.2 L	088[12.6 Ht	090 10.2 Pt	110 10.0 L
T Pic	110 12.3 L	083 12.7 B	092[12.2 En	091 10.1 Pt	112 10.4 B
051247	S Ori	084 12.5 L	094 13.1 Bl	093 10.1 Pt	V Aur
042 9.0 En	*052404*	084 12.4 Nz	Z Tau	093 10.7 B	061647
056 9.5 Sm	062 10.0 Ch	088 13.0 L	054615a	093 10.8 HS	071 10.8 Ch
060 9.5 En	071 9.8 Ch	090 13.5 L	073 12.8 Nz	096 10.6 Jo	079 9.5 L
060 9.3 Ht	091 9.6 B	091 13.5 L	083 13.2 L	098 10.3 Pt	083 10.0 B
067 9.4 Ht	T Ori	092 13.5 L	084 12.6 Nz	099 10.4 Pt	097 9.5 L
069 10.1 Bl	*053005a*	093 13.2 L	096 11.7 Ch	100 10.7 HS	110 9.3 L
070 9.4 Dr	062 9.6 Ch	097 13.4 L	RS Tau	101 10.2 Pt	V Mon
072 10.2 Ht	069 9.8 L	101 13.3 L	054615b	102 10.3 Pt	*061702*
072 9.8 Sm	071 9.6 Ch	RU Aur	096 9.4 Ch	103 10.3 Pt	096[12.6 Ch
079 9.9 Bl	072 10.4 L	053337	RU Tau	104 10.3 Pt	AG Aur
083 10.2 Ht	074 10.0 L	071[12.1 Ch	054615c	105 10.6 Pt	062047
084 10.6 En	077 10.0 L	089[12.0 Pt	073 12.0 Nz	106 10.6 Pt	073 9.1 L
088 10.7 Ht	078 10.0 L	U Aur	083 12.1 L	113 10.7 HS	079 9.0 L
089 10.5 Dr	079 9.7 L	053531	084 12.3 Nz	117 9.9 Pt	091 9.9 L
092 10.6 En	081 9.8 L	063 9.8 Ch	R Col	119 10.2 Pt	106 10.4 L
093 11.1 Ht	081 10.4 Pt	078 9.4 L	*054629*	123 10.0 Pt	114 10.6 L
094 11.1 Bl	081 10.6 Jo	082 10.0 B	056[12.4 Sm	124 10.0 Pt	U Lyn
111 11.4 Bl	083 10.1 Ch	087 10.5 Sf	065[13.0 En	125 10.0 Pt	063159
117 11.8 Bl	083 10.9 B	089 10.4 Pt	067[13.0 Ht	127 10.1 Pt	083 13.7 B
Nov Tau	083 9.8 L	091 10.6 L	069[13.0 Bl	130 9.9 Pt	R Mon
051316	087 11.3 Jo	093 10.6 Sf	072[12.4 Sm	R Oct	063308
083 14.0 L	093 11.3 Jo	110 10.9 L	083[13.0 Ht	*055686*	083 12.2 Ch
T Col	093 10.6 Pt	SU Tau	092[12.4 En	060 11.6 En	093 11.8 B
051533	093 11.2 L	054319	094[13.0 Bl	063 12.0 Ht	Nov Pic
042 12.1 En	097 11.1 L	062 9.8 Ch	117[13.0 Bl	065 11.6 En	*063162*
060 10.7 En	099 10.6 Pt	071 9.7 Ch	α Ori	067 11.8 Ht	058 8.4 Sm
060 10.8 Ht	AN Ori	073 9.5 L	054907	069 11.8 Bl	060 8.1 En
067 10.5 Ht	*053005t*	077 9.5 L	067 0.2 L	079 11.5 Bl	060 8.3 Ht
069 9.9 Bl	093 11.6 L	079 9.5 L	093 0.2 L	083 11.6 Ht	065 8.2 En

Variable Star Observations Received During May and June, 1930.

J.D.Est.Obs.

Nov Pic
063462
067 8.4 Ht
072 8.1 Ht
072 8.2 En
083 8.2 Ht
084 8.2 En
088 8.3 Ht
092 8.1 En
093 8.3 Ht

S Lyn
063558
083 13.4 L
089 13.7 Pt
101 12.4 Bw
117 14.0 L

X Gem
064030
083 8.3 B
089 8.3 Bn
105 8.8 B
107 8.6 Bw

Y Mon
065111
071 10.0 Ch
077 9.4 L
089 9.2 L
091 9.2 B
110 9.8 L

X Mon
065208
077 8.1 Tf
077 8.2 L
089 7.9 L
097 7.3 Tf
101 7.5 L

R Lyn
065355
097 13.4 L
117 13.1 L

V CMi
070109
090[13.2 Ch
117[13.5 L

R Gem
070122a
062 9.9 Ch
074 9.7 B
082 10.4 Jo
087 10.5 Jo
088 11.1 Sw
089 10.5 Pt
090 10.6 Ah
091 10.0 Ch
095 10.7 Jo
112 10.8 B
119 12.8 Pt

J.D.Est.Obs.

Z Gem
070122b
119 12.6 Pt

TW Gem
070122c
089 8.1 Pt
119 7.9 Pt

R CMi
070310
073 9.4 L
083 9.7 B
087 9.6 Sf
088 9.6 L
090 9.6 Ch
093 9.5 Sf
101 9.5 Sf
109 8.8 L

R Vol
070772
058 11.8 Sm
060 12.0 En
060 11.8 Ht
065 12.2 En
067 11.8 Ht
070 11.8 Dr
072 12.2 Ht
083 12.6 Ht
088 12.6 Ht
088 13.2 En
089 11.9 Dr
093 12.8 Ht
096 12.0 Dr

L_2 Pup
071044
070 4.4 Dr
073 4.2 Dr
082 4.2 Dr
087 4.2 Dr
096 4.2 Dr

RR Mon
071201
081 9.5 Ch
087 9.4 Sf
093 9.4 Sf
101 9.8 Sf

V Gem
071713
083 12.0 Ch
083 12.0 L
089 11.6 Pt
091 11.4 B
091 11.4 L
109 10.1 L
119 12.4 Pt

S CMi
072708
062 11.8 Ch
083 12.6 Ch
089 12.7 Pt
091 12.5 B

J.D.Est.Obs.

S CMi
072708
119 12.4 Pt

T CMi
072811
083[13.2 Ch
085[14.2 L

Z Pup
072820b
060[13.0 En
073[13.7 Nz
084[13.7 Nz
092[12.1 En

S Vol
073173
058 10.5 Sm
060 9.2 En
060 10.5 Ht
065 9.5 En
067 10.5 Ht
070 11.0 Dr
070 10.8 Bl
072 10.5 Ht
079 10.5 Bl
082 10.4 Dr
083 10.5 Ht
088 10.2 Ht
088 10.4 En
089 10.5 Dr
092 10.4 En
093 10.2 Ht
094 10.7 Bl
096 10.4 Dr
111 9.3 Bl
117 9.3 Bl

U CMi
073508
083 13.3 L
091 13.1 B
097 13.2 L
109 13.0 L

S Gem
073723
062 11.8 Ch
071 12.2 Ch
081 11.5 Jo
082 12.1 B
087 11.7 Jo
089 12.7 Pt
089 12.3 Bw
091 12.8 Ch
113 13.0 B
119 14.0 Pt

W Pup
074241
044 8.1 Sm
060 9.2 En
061 9.1 Ht
065 9.5 En
067 9.4 Ht

J.D.Est.Obs.

W Pup
074241
070 9.5 Dr
070 9.4 Bl
072 9.6 Ht
072 10.1 En
079 10.0 Bl
082 10.1 Dr
084 11.0 Ht
084 11.1 En
087 10.4 Dr
088 11.2 Ht
089 11.0 Dr
092 11.2 En
093 11.4 Ht
094 11.2 Bl
096 11.2 Dr
111 11.9 Bl
117 11.6 Bl

T Gem
074323
062 9.1 Ch
071 9.3 Ch
074 9.7 B
081 9.9 Jo
087 10.0 Jo
089 10.5 Pt
095 11.6 Jo
112 11.9 B

U Pup
075612
083 13.3 Ch

R Cnc
081112
064 8.6 Ch
071 9.8 Be
074 7.3 B
087 7.5 Wd
088 7.2 Ah
089 7.3 Pt
090 7.2 Ah
093 7.4 Wd
093 7.2 HS
096 7.0 Ch
098 6.9 Ah
099 6.9 Ah
100 7.3 HS
100 7.4 Wd
105 7.0 B
109 7.5 Wd
113 7.3 HS
119 7.2 Fd
119 7.5 Pt

V Cnc
081617
064 7.8 Ch
074 8.0 B
077 7.8 L
082 7.6 Ch
087 8.2 Gy

J.D.Est.Obs.

V Cnc
081617
087 8.2 Wd
088 8.2 Ah
089 7.8 L
090 8.4 Ah
093 8.7 HS
095 8.1 Gy
095 8.4 Ah
096 8.6 Ah
099 8.7 Ah
100 8.7 HS
105 8.6 B
109 8.3 L
113 8.6 HS
113 9.3 Ah
119 9.0 Pt
119 8.8 HS

RT Hya
082405
089 8.0 Pt

R Cha
082476
055 11.6 Sm
060 11.3 En
060 11.5 Ht
065 11.5 En
067 12.0 Ht
070 12.0 Bl
072 12.2 Ht
083 12.4 Ht
088 12.4 Ht
088 12.4 En
093 12.3 Ht
094 12.5 Bl
117 12.9 Bl

U Cnc
083019
078 12.6 L
082 12.4 Ch
083 13.5 B
090 13.9 L
112 13.6 B

X UMa
083350
089 13.6 Pt
100[13.2 B
116[13.0 B

S Hya
084803
064 8.8 Ch
074 9.7 B
089 10.4 Ah
089 10.2 Pt
093 10.4 Ch
112 10.9 B
119 11.3 Pt

T Hya
085008
064 9.3 Ch
082 8.0 Jo
083 8.2 Ch
086 8.7 BL
087 8.9 BL
087 8.0 Jo
089 9.3 Ah
089 8.0 Pt
091 9.0 BL
093 8.9 BL
095 8.1 Jo
096 8.7 BL
100 8.3 BL
103 8.4 BL
104 8.3 BL
105 8.5 BL
106 8.4 BL
112 8.5 BL
113 8.3 BL
113 8.0 Jo
118 8.2 Jo
118 8.4 BL
119 8.3 BL
119 7.9 Pt
122 8.1 BL
124 8.4 BL
127 8.4 BL
128 8.4 Jo
129 8.2 BL
131 8.3 BL
141 8.0 BL

J.D.Est.Obs.

T Hya
085008
074 7.8 B
077 7.5 L
082 7.4 Jo
087 7.4 Jo
089 7.0 Pt
089 7.5 Sw
089 7.3 L
093 7.4 Tf
093 7.2 Ch
095 7.5 Jo
097 7.5 Tf
108 7.7 L
119 8.3 Pt

T Cnc
085120
064 9.3 Ch
082 8.0 Jo
083 8.2 Ch
086 8.7 BL
087 8.9 BL
087 8.0 Jo
089 9.3 Ah
089 8.0 Pt
091 9.0 BL
093 8.9 BL
095 8.1 Jo
096 8.7 BL
100 8.3 BL
103 8.4 BL
104 8.3 BL
105 8.5 BL
106 8.4 BL
112 8.5 BL
113 8.3 BL
113 8.0 Jo
118 8.2 Jo
118 8.4 BL
119 8.3 BL
119 7.9 Pt
122 8.1 BL
124 8.4 BL
127 8.4 BL
128 8.4 Jo
129 8.2 BL
131 8.3 BL
141 8.0 BL

T Pyx
090031
094 r Bl
111 [u Bl
117 [w Bl

V UMa
090151
078 10.1 L
090 10.0 L
093 10.0 Sf
100 10.0 B
110 10.2 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.

V UMA
090151
113 10.2 B
113 10.2 Sf
119 10.5 Sf
127 10.6 Sf

W CNC
090425
073 11.9 L
083 11.4 Ch
088 11.4 L
091 11.2 Sf
100 10.4 B
109 10.3 L
113 10.0 B
113 10.2 Sf
118 9.8 Sf
124 9.4 Sf
141 8.5 Sf

RX UMA
090567
078 11.3 L
090 11.3 L
109 11.5 L

RW CAR
091868
038[12.8 En
060[12.8 Ht
070 13.4 Bl
084 12.8 Ht
088 12.8 Ht
089 12.2 En
093 12.2 Ht
094 12.3 Bl
095 12.0 En
096 11.9 Dr
111 12.0 Bl
117 11.7 Bl

Y VEL
092551
038[12.4 En
056[12.9 Sm
060[12.9 Ht
070 13.5 Bl
072[12.4 Sm
084[12.9 Ht
089[12.4 En
094 13.5 Bl
111 13.3 Bl
117 13.3 Bl

R CAR
092962
038 7.8 En
041 8.0 Sm
052 9.0 En
056 8.5 Sm
060 8.8 Ht
067 9.2 Ht
070 9.0 Dr
070 9.2 Bl

R CAR
092962
072 8.9 Sm
072 9.3 Ht
079 9.2 Bl
082 9.3 Dr
083 9.4 Ht
087 9.4 Dr
088 9.4 Ht
089 9.2 En
093 9.6 Ht
094 9.3 Bl
095 9.2 En
096 9.2 Dr
111 9.8 Bl
117 9.8 Bl

X HYA
093014
064 8.5 Ch
073 9.2 Nz
074 9.2 B
083 9.1 Ch
084 9.1 Nz
087 9.2 Gy
089 8.9 Pt
089 9.2 Sw
095 9.7 Gy
119 10.5 Pt

Y DRA
093178
083 13.9 L
097 14.6 L
116 14.4 L

R LMI
093934
062 11.0 Ch
071 10.5 Bc
086 10.3 Fd
087 10.2 Al
087 9.8 Gy
089 10.1 Ah
089 10.1 Pt
091 9.8 Fd
092 9.9 Fd
093 10.0 HS
095 9.7 Gy
095 9.7 Ah
096 9.7 Ah
099 9.5 Fd
099 9.3 Ah
100 9.0 Ah
100 9.4 HS
101 8.9 Bc
104 8.6 Al
105 8.0 B
113 7.7 HS
113 8.1 Ah
113 7.6 Wd
116 8.2 Ah

R LMI
093934
117 7.5 Fd
118 7.5 Wd
119 7.4 Fd
119 7.2 Pt
119 7.7 Ah
119 7.4 HS
120 7.0 Jo
121 7.3 Fd
122 7.1 HS
122 7.9 Ah
123 7.4 Wd
124 7.9 Ah
125 7.9 Ah
127 7.2 Fd
127 7.7 Wd
127 8.0 Ah
128 7.3 HS
128 6.8 Jo
131 7.4 HS
132 7.1 Wd
133 7.3 Wd

RR HYA
094023
056 12.8 En
060 12.5 Dr
070 12.0 Dr
073 12.3 Nz
083 11.9 L
084 11.9 Nz
089 11.8 En
089 11.1 Dr
095 11.1 En
096 11.0 Dr
116 9.6 L

R LEO
094211
068 8.6 Ch
068 8.4 Ah
072 7.5 Bc
081 8.0 Jo
086 7.5 Fd
086 7.8 Pt
086 7.7 BL
086 7.7 Ma
087 7.7 BL
087 7.0 Al
087 8.8 Wd
087 8.5 Sf
087 8.1 Jo
088 8.3 Ah
088 7.5 Bc
089 8.3 Ah
089 7.7 Fd
089 8.4 Sw
090 8.3 Ah
091 7.7 Fd
091 7.8 BL
092 7.7 Fd

R LEO
094211
093 7.6 BL
093 8.6 Wd
093 8.0 Jo
093 8.3 Tf
093 8.2 Ch
093 8.5 Sf
095 7.7 Ah
096 8.0 Ah
096 8.7 Ll
096 7.7 BL
096 8.0 Jo
097 8.2 Tf
098 7.4 Ma
098 8.0 Ah
099 7.9 Ah
099 7.3 Fd
100 7.4 Fd
100 7.5 BL
100 8.2 Wd
100 8.4 Sw
101 8.1 HS
101 7.5 Bc
103 7.2 BL
103 8.2 Wd
104 6.8 Al
104 7.2 BL
105 7.3 BL
105 7.3 B
106 7.4 BL
106 7.8 Ah
107 8.3 Wd
107 7.8 Sf
109 8.1 Wd
112 7.1 BL
113 6.8 BL
113 7.9 HS
113 6.8 Jo
113 6.9 Ah
113 7.4 Wd
117 6.8 Fd
118 6.4 Jo
118 6.5 BL
118 7.4 Sf
118 7.2 Wd
119 6.1 Pt
119 6.5 Fd
119 6.6 HS
119 6.4 BL
120 6.2 Ma
121 6.3 Fd
122 6.6 HS
122 6.3 BL
122 6.4 Ah
124 6.5 Ah
124 6.3 BL
124 6.7 Sf
125 6.4 Ah
127 6.0 Jo

R LEO
094211
127 6.2 BL
127 6.2 Sf
127 6.5 Wd
128 5.9 HS
129 5.9 BL
130 5.8 Wd
131 5.8 BL
131 5.8 HS
132 5.6 Wd
133 5.6 Wd
138 5.6 BL
141 5.6 BL
141 6.1 Sf
142 5.8 HS

Y HYA
094622
038 8.0 En
056 7.8 En
064 7.0 Ch
086 6.6 Pt
089 8.0 En
095 7.5 En
119 6.5 Pt

Z VEL
094953
044[12.1 Sm
052[12.1 En
067[12.8 Ht
070[13.5 Bl
072[12.1 Sm
084[12.8 Ht
089[12.1 En
093[12.8 Ht
095[12.8 En
117[13.3 Bl

V LEO
095421
064 10.4 Ch
086 11.6 Pt
099 12.6 BE
100 12.5 B
113 12.9 B
119 12.5 Pt
127 13.3 BE

RR CAR
095458
038 8.2 En
052 8.2 En
060 8.4 Ht
067 8.4 Ht
072 8.4 Ht
083 8.4 Ht
088 8.4 Ht
089 7.9 En
093 8.4 Ht
095 8.0 En

RV CAR
095563
060 11.6 Ht
060 11.6 En
067 11.6 Ht
070 11.4 Bl
072 11.4 Ht
079 11.3 Bl
084 11.3 Ht
088 11.4 Ht
089 11.6 En
089 11.2 Dr
093 11.5 Ht
094 11.4 Bl
095 11.5 En
096 11.5 Dr
111 11.7 Bl
117 12.1 Bl

RY LEO
095814
041 9.0 Kl
095 10.4 Kl

S CAR
100661
038 9.2 En
041 8.6 Sm
056 8.0 Sm
060 7.3 Ht
060 7.0 En
067 6.8 Ht
070 6.5 Dr
070 6.8 Bl
072 6.5 Sm
072 6.7 Ht
079 6.5 Bl
082 5.9 Dr
083 6.3 Ht
088 6.2 Ht
089 6.1 Dr
089 6.3 Dr
089 6.2 En
093 6.0 Ht
094 6.0 Bl
095 5.8 En
096 5.3 Dr
111 5.5 Bl
117 5.5 Bl

U UMA
100860
064 6.8 Ch

Z CAR
101058a
041[12.3 Sm
060[12.3 En
070 13.4 Bl
084[12.3 Ht
089[12.3 En
093[12.3 Ht
117[12.6 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
W VEL	V HYA	RS CEN	W CEN	SS VIR	T UMA
101153	*104620*	*111661*	*115058*	122001	123160
038 10.5 En	094 7.0 Bl	038 8.9 En	096 9.9 En	083 8.4 L	081 11.0 Jo
041 9.8 Sm	096 6.5 En	041 8.9 Sm	112 10.9 Bl	089 9.2 B	086 11.0 Pt
056 9.5 Sm	112 6.7 L	056 9.7 Sm	117 11.1 Bl	097 8.1 L	086 10.0 Fd
060 9.0 Ht	111 7.0 Bl	060 10.5 En	R COM	112 8.4 L	087 10.8 Jo
060 9.2 En	117 6.8 Bl	060 10.5 Ht	115919	121 7.9 B	088 10.3 Ah
067 8.6 Ht	119 6.3 Pt	067 11.2 Ht	064 8.5 Ch	T CVN	089 10.1 Ah
070 8.6 Dr	RS HYA	070 11.5 Dr	080 8.3 Br	122532	090 10.0 Ah
070 8.5 Bl	*104628*	070 11.5 Bl	081 7.9 Jo	082 12.1 Ch	091 10.1 Fd
072 8.9 Sm	039 9.8 En	072 11.6 Sm	086 8.5 Pt	086 12.6 Pt	092 9.8 B
072 9.0 Ht	067 10.1 En	072 12.0 Ht	087 8.5 Jo	100 11.9 BL	092 9.7 Ah
079 9.0 Bl	070 10.3 Bl	079 12.3 Bl	095 8.8 Jo	103 11.8 BL	093 10.4 HS
083 9.3 Ht	079 10.6 Bl	084 13.0 Ht	100 9.0 BL	104 12.0 BL	094 9.6 Ah
088 9.2 Ht	091 11.1 En	089 13.1 Dr	103 8.9 BL	107 11.4 Lg	094 10.3 Ch
089 8.8 Dr	094 11.5 Bl	094 13.1 Bl	104 8.8 BL	112 12.0 BL	095 9.0 Jo
089 9.3 En	096 11.4 En	117 13.4 Bl	106 8.9 BL	113 12.0 BL	098 9.6 Ma
093 9.1 Ht	111 12.0 Bl	X CEN	112 9.2 BL	118 11.9 BL	099 9.5 Ah
094 9.3 Bl	117 12.2 Bl	*114441*	113 9.3 BL	118 11.5 Pt	099 9.3 Fd
095 9.3 En	W LEO	038 12.9 En	118 9.0 Jo	119 11.8 BL	100 8.9 Fd
096 9.4 Dr	104814	060[12.2 Ht	118 9.5 BL	121 12.0 Fd	100 9.4 Ah
111 9.5 Bl	081 13.6 Ch	070[13.5 Bl	119 9.6 BL	122 11.9 BL	101 9.6 HS
117 9.5 Bl	083 13.7 L	084[13.1 Ht	122 9.6 BL	124 11.8 BL	103 9.6 Wd
U HYA	084 14.0 Br	091[12.2 En	124 9.7 BL	127 11.6 BL	106 9.0 Wd
103212	087 13.6 Nz	096[12.2 En	127 9.6 BL	127 11.4 Fd	109 9.0 Wd
064 5.3 Ch	099 13.5 BE	117[13.1 Bl	127 9.7 Jo	129 11.5 BL	113 8.9 HS
081 5.0 L	100 13.4 BE	AD CEN	129 9.7 BL	131 11.4 BL	113 8.8 Jo
090 4.9 L	112 13.4 B	*114858*	131 10.0 BL	138 11.5 BL	113 8.8 Ah
112 5.3 L	112 13.4 L	038 9.2 En	138 9.7 BL	141 10.7 BL	113 8.9 Wd
RZ CAR	117 13.0 BE	041 9.1 Sm	141 9.8 BL	Y VIR	116 8.6 Ah
103270	119 13.5 Pt	058 8.6 Sm	118 9.8 Pt	*122803*	118 8.5 Ah
038[12.7 En	127 12.8 BE	060 9.5 Ht	SU VIR	083 13.2 L	118 8.8 Wd
060[13.1 Ht	142 12.4 Ma	067 9.1 Ht	120012	087 13.3 Nz	118 8.5 Jo
084[13.1 Ht	RS CAR	072 9.5 Ht	064 9.8 Ch	092 12.9 B	118 8.5 Ma
089[13.6 Dr	*110361*	072 8.6 Sm	084 11.2 Br	097 12.5 L	118 8.4 Pt
093[13.1 En	056[12.3 Sm	083 9.5 Ht	086 11.4 Pt	112 11.8 L	119 8.6 Ah
R UMA	072[12.3 Sm	088 9.5 Ht	087 11.6 Bw	119 11.0 Ma	119 8.9 HS
103769	S LEO	093 9.3 Ht	100 10.1 BE	121 10.8 B	121 8.5 Fd
063 11.6 Ch	110506	096 9.6 En	101 12.2 Bw	142 9.8 Ma	122 8.2 HS
070 11.8 Ch	081 12.8 Ch	W CEN	118 13.0 Pt	U CEN	122 8.4 Ah
086 12.0 Fd	081 12.3 L	*115058*	120 12.4 BE	*122854*	123 8.3 Wd
086 12.6 Pt	093 11.7 L	038 8.8 En	128 12.6 Bw	038 9.8 En	124 8.3 Ah
091 12.7 Br	109 11.0 L	041 8.6 Sm	T VIR	060 8.7 En	125 8.2 Ah
091 12.4 Fd	112 11.2 B	052 8.1 En	*120905*	060 8.9 Ht	127 8.1 Ah
113 13.1 B	119 10.4 Ma	058 7.8 Sm	082 12.8 Ch	067 8.4 Ht	127 8.2 Wd
119 13.0 Pt	119 10.7 Pt	060 8.2 Ht	083 12.5 L	070 8.5 Dr	127 8.5 Fd
144 10.1 Mc	128 10.1 Ma	067 8.5 En	086 13.2 Pt	070 8.1 Bl	127 8.3 Jo
V HYA	RY CAR	067 8.0 Ht	088 12.7 B	072 8.5 Ht	128 8.1 Ma
104620	*111561*	070 8.1 Dr	112 13.2 B	079 8.2 Bl	128 8.5 HS
039 6.1 En	038[12.7 En	070 8.3 Bl	112 13.4 L	083 8.5 Ht	128 8.2 Ah
054 7.0 Ch	056[12.7 Sm	072 8.2 Sm	R CRV	088 8.4 Ht	130 7.9 Wd
067 6.7 En	060[13.1 Ht	072 8.3 Ht	*121418*	089 8.5 Dr	131 8.2 HS
068 7.1 Ch	070[13.5 Bl	079 8.8 Bl	083 12.0 L	093 8.1 Ht	132 8.0 Wd
070 6.9 Bl	072[12.1 Sm	083 9.3 Ht	086 11.7 Pt	094 8.5 Bl	133 8.1 Wd
078 6.6 L	084[13.1 Ht	088 9.7 Ht	087 11.9 Nz	096 9.0 En	142 8.1 Ma
079 6.8 Bl	089[13.5 Dr	089 9.2 Dr	092 12.1 B	112 9.3 Bl	142 8.3 HS
086 6.2 Pt	091[12.7 En	091 9.4 En	112 13.3 B	117 9.7 Bl	R VIR
090 6.6 L	096[13.1 En	093 9.9 Ht	112 12.0 L	T UMA	123307
091 6.5 En	117 12.7 Bl	094 9.7 Bl	118 12.0 Pt	123160	063 10.2 Ch
092 7.6 Ch		096 9.7 Dr	141 11.3 Mc	070 12.3 Ch	068 10.2 Ah

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R VIR	S UMA	S UMA	U OCT	S VIR	T CEN
123307	123961	123961	*131283*	*132706*	*133633*
082 9.1 Ch	041 8.7 Kl	128 8.6 Ma	093 9.6 Ht	101 9.4 HS	039 6.2 Ht
086 8.4 Ma	068 8.0 Lj	130 8.9 Wd	095 9.2 Bl	103 9.5 Jo	056 6.5 Sm
086 8.5 Fd	068 7.8 Ah	132 8.9 Wd	096 9.4 En	113 8.8 Jo	060 6.5 Ht
086 8.2 Pt	075 7.6 B	133 9.0 Wd	112 8.5 Bl	118 8.0 Pt	067 6.7 Ht
088 8.6 Ah	081 7.6 Jo	142 9.0 Ma	117 8.4 Bl	120 8.0 Jo	070 6.6 Dr
091 8.0 Fd	082 8.2 Ch	RU VIR	V VIR	122 8.2 HS	070 6.7 Bl
092 8.3 Ah	086 7.3 Fd	124204	*132202*	124 8.1 HS	072 6.8 Sm
092 8.3 Fd	086 7.7 Pt	083 10.3 L	020 12.5 Ma	127 7.9 HS	072 6.7 Ht
095 7.8 Ah	087 7.7 Wd	086 10.4 Br	069 13.4 L	127 8.0 Jo	079 6.7 Bl
096 7.7 Ah	087 7.8 Ah	086 10.5 Pt	086 13.2 Ma	128 7.3 HS	084 7.4 Ht
096 8.3 Ll	087 7.6 Jo	087 11.0 Bw	093 13.7 B	130 8.3 Jo	087 7.6 Dr
098 7.7 Ma	088 7.7 Ah	092 10.4 B	112 13.7 L	131 7.0 HS	088 7.8 Ht
099 7.7 Fd	089 7.9 Ah	101 11.1 Bw	117 13.7 B	142 7.0 HS	089 7.4 Dr
099 7.4 Ah	089 8.0 Lj	112 11.6 L	R HYA	RV CEN	091 8.0 En
100 7.3 Ah	090 7.9 Ah	118 12.1 Pt	*132422*	*133155*	093 7.8 Ht
100 7.5 B	091 7.3 Fd	128 12.0 Bw	039 7.6 Ht	061 10.2 Ht	095 7.7 Bl
100 7.7 Fd	092 8.0 Lj	U VIR	040 7.6 En	063 10.0 En	097 7.8 En
102 7.4 Ah	092 7.8 Ah	124606	056 7.9 En	067 10.2 Ht	112 6.7 Bl
113 7.2 Ah	093 7.7 Wd	074 11.5 L	056 8.0 Sm	070 9.6 Bl	117 6.6 Bl
113 7.0 Jo	094 7.9 Lj	086 10.4 Ma	060 8.0 Ht	072 10.1 Ht	RT CEN
116 7.0 Ah	094 7.3 Ah	086 10.3 Br	063 7.8 En	079 9.4 Bl	*134236*
118 6.9 Jo	095 7.5 Jo	088 10.0 Ah	067 8.4 Ht	084 9.9 Ht	039 10.9 Ht
118 7.1 Pt	097 7.9 Lj	090 9.7 L	068 8.5 Ch	088 9.8 Ht	056 11.6 Sm
119 7.0 Ma	098 8.1 Ma	091 9.7 Fd	070 8.3 Bl	091 10.0 En	061 11.4 Ht
119 7.0 Ah	099 7.8 Fd	091 10.0 Ch	072 8.1 Sm	093 9.7 Ht	063 12.4 En
119 6.8 Fd	099 7.7 Ah	092 10.1 B	079 8.0 Bl	095 9.3 Bl	067 11.4 Ht
121 7.4 Fd	100 7.5 Ah	095 9.7 Ah	083 8.4 L	097 9.4 En	070 12.1 Dr
122 7.0 Ah	100 7.8 Fd	099 9.2 Fd	084 8.6 Ht	112 9.1 Bl	070 12.0 Bl
124 7.0 Ah	101 8.0 Lj	099 9.5 Ah	093 9.2 Ch	117 9.1 Bl	072 11.6 Ht
125 6.9 Ah	103 8.0 Wd	100 9.5 Ah	086 8.7 Pt	T UMI	084 11.9 Ht
127 6.8 Ah	107 8.5 Wd	112 8.8 L	088 9.0 Ht	133273	088 12.4 Ht
127 6.7 Jo	109 8.7 Wd	113 8.8 Ah	093 9.0 Ht	074 11.5 L	089 12.9 Dr
127 6.6 Fd	113 8.5 Lj	116 8.7 Ah	095 9.2 Bl	089 9.8 Sf	093 12.7 Ht
128 7.0 Ah	113 8.4 Jo	119 8.9 Ah	097 9.0 En	090 9.5 L	095 13.4 Bl
128 7.2 Ma	113 8.5 Ah	119 8.8 Fd	097 9.0 Tf	093 9.3 Sf	097 12.9 En
133 7.9 Wd	113 8.8 Wd	122 8.5 Ah	112 9.1 L	097 9.1 Sf	118 12.8 Bl
142 7.2 Ma	116 8.7 Lj	124 8.4 Ah	112 9.0 Bl	100 9.2 BL	R CVN
144 8.7 Mc	116 8.5 Ah	125 8.4 Ah	117 9.1 Bl	103 9.1 BL	134440
RS UMA	118 8.6 Jo	127 8.3 Ah	118 9.5 Pt	104 8.9 BL	086 7.6 Pt
123459	118 8.3 Ma	128 8.3 Ah	S VIR	106 8.9 BL	086 7.6 BL
068 9.3 Ch	118 8.4 Ah	RV VIR	*132706*	112 8.7 BL	087 7.6 BL
075 9.5 B	118 8.7 Wd	*130212*	039 11.7 Ht	112 8.8 L	087 7.5 Gy
081 9.5 Jo	118 8.2 Pt	055 11.5 Sm	060 11.5 Ht	113 9.1 Sf	088 7.3 Ah
082 9.5 Ch	119 8.7 Lj	083 14.5 L	063 11.0 En	113 8.9 BL	089 7.5 Sw
086 10.4 Pt	119 8.5 Ah	112 14.5 L	067 11.3 Ht	118 9.0 BL	090 7.4 Ah
086 10.5 Fd	121 8.7 Lj	U OCT	071 10.8 Ch	119 9.1 Sf	091 7.5 BL
087 9.6 Jo	121 8.6 Fd	*131283*	072 10.5 Sm	119 8.9 BL	092 7.4 Ah
087 10.3 Nz	122 8.5 Ah	060 11.6 Ht	084 10.5 Ht	122 9.1 BL	093 7.5 BL
089 10.5 Bn	123 8.9 Wd	063 11.2 En	086 10.4 Ma	124 9.4 BL	094 7.0 Ah
091 10.9 Fd	124 8.6 Ah	067 11.4 Ht	086 10.1 Pt	124 8.8 Jo	095 7.3 Ah
095 9.7 Jo	125 8.6 Ah	070 10.8 Dr	087 10.5 Jo	127 9.5 BL	095 7.4 Ch
098 10.9 Ma	126 8.9 Lj	070 8.3 Bl	088 10.5 Ht	127 9.3 Sf	096 7.4 Ah
099 11.7 Fd	127 8.7 Be	079 8.0 Bl	091 9.9 En	127 9.4 Wd	099 7.4 Ah
100 11.4 Fd	127 8.6 Jo	082 10.1 Dr	092 9.9 B	128 9.0 Jo	100 7.6 BL
103 10.1 Wd	127 8.7 Ah	083 10.3 Ht	093 10.2 Jo	129 9.6 BL	100 7.3 Ah
115 13.0 Bn	127 8.6 Fd	088 9.9 Ht	093 10.6 Ht	131 9.7 BL	103 7.9 BL
118 13.0 Pt	127 9.0 Wd	089 9.8 Dr	096 10.0 Jo	138 9.8 BL	104 7.8 BL
128 13.3 Ma	128 8.7 Ah	091 9.5 En	097 10.1 En	141 10.2 BL	106 7.7 BL

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.	Est.	Obs.
R CVn		
134440		
112	7.8	BL
113	7.8	BL
113	7.8	Ah
116	7.8	Ah
118	7.8	Ah
118	7.9	BL
118	8.0	Pt
119	8.0	Ah
119	8.0	BL
121	7.9	Fd
122	8.3	Ah
122	7.8	BL
124	7.9	BL
124	8.3	Ah
125	8.3	Ah
127	8.4	Ah
127	7.9	BL
128	8.4	Ah
129	8.2	BL
131	8.1	BL
138	8.3	BL
141	8.7	BL
RX Cen		
134536		
039	11.2	Ht
061	12.0	Ht
063	12.1	En
067	12.4	Ht
070	12.4	Dr
070	12.6	Bl
072	12.6	Ht
084	13.1	Ht
088	13.2	Ht
089	13.0	Dr
095	13.4	Bl
T Aps		
134677		
055[	12.7	Sm
063[	12.3	En
070[	13.2	Bl
084[	12.7	Ht
093[	13.2	Ht
097[	12.7	En
118[	13.2	Bl
Z Boo		
140113		
090	14.5	L
114	13.9	L
126	13.3	Br
128	12.8	Ma
142	10.5	Ma
Z Vir		
140512		
084	13.6	L
096[	13.2	Ch
114	13.8	L

J.D.	Est.	Obs.
RU Hya		
140528		
039	13.2	Ht
061	13.3	Ht
065[	12.5	En
071[	13.5	Bl
084[	12.9	Ht
091[	12.5	En
097[	12.5	En
118[	13.5	Bl
R Cen		
140959		
044	9.8	Sm
056	10.0	En
058	10.0	Sm
061	10.5	Ht
065	9.7	En
067	10.6	Ht
070	9.8	Dr
071	10.0	Bl
072	10.6	Ht
079	10.1	Bl
082	9.7	Dr
083	10.5	Ht
088	10.7	Ht
089	10.0	Dr
091	10.5	En
093	10.5	Ht
095	10.2	Bl
097	10.5	En
112	9.7	Bl
118	9.8	Bl
U UMi		
141567		
068	9.9	Lj
081	9.8	Jo
086	9.4	Pt
087	9.7	Jo
089	9.6	Ah
089	9.2	Lj
090	9.7	Ah
092	9.3	Lj
093	9.5	Jo
094	9.5	Lj
097	9.3	Lj
099	9.5	Ah
100	9.2	Ah
100	9.0	B
101	9.3	Lj
107	8.8	Lg
113	9.0	B
113	9.1	Lj
113	9.1	Ah
116	9.1	Lj
118	9.1	Ah
118	8.9	Pt
119	8.8	Ah
119	9.0	Lj
121	9.1	Lj
122	8.5	Ah

J.D.	Est.	Obs.
U UMi		
141567		
124	8.4	Ah
124	8.5	Jo
125	8.4	Ah
126	9.0	Lj
127	8.5	Ah
128	8.7	Ah
128	8.2	Jo
S Boo		
141954		
071	10.9	Ch
081	11.0	Jo
086	12.1	Br
086	11.8	Pt
086	11.4	BL
087	11.5	BL
087	11.7	Jo
089	11.8	B
089	12.2	Sw
090	12.2	L
091	11.6	BL
093	11.8	BL
093	12.0	Jo
100	12.1	BL
116	13.1	L
117	12.7	Pt
126	13.0	Br
RS Vir		
142205		
084	12.6	L
086	12.6	Br
087	13.3	Nz
092	13.0	B
096	13.3	Ch
114	13.7	L
120	13.7	B
126	14.4	Br
V Boo		
142539a		
071	9.2	Ch
080	9.3	Sw
081	8.5	Jo
086	9.2	Pt
087	9.5	Sf
087	8.7	Jo
088	8.1	Gb
089	9.5	Fd
089	9.3	B
090	8.9	Ah
092	9.5	Fd
093	8.9	Jo
093	9.4	Sf
095	9.0	Ah
095	9.4	Ch
096	9.0	Ah
096	9.5	Jo
099	9.6	Fd
100	9.3	Fd
100	9.7	Sf

J.D.	Est.	Obs.
V Boo		
142539a		
100	9.0	Ah
104	9.2	Al
113	10.2	Jo
113	9.8	Sf
113	9.6	Ah
116	9.8	Ah
117	9.9	Pt
118	9.4	Jo
119	10.1	Sf
119	9.9	Ah
119	10.5	Fd
121	10.0	Fd
122	10.0	Ah
124	10.1	Ah
125	10.2	Ah
127	9.2	Jo
127	10.0	Fd
128	10.2	Ah
130	8.5	Jo
R Cam		
142584		
093[	10.9	Ch
126	12.0	Br
R Boo		
143227		
071	12.6	Ch
082	12.0	Jo
086	13.1	Pt
087	11.8	Jo
089	12.6	B
089	12.6	Lj
092	12.6	Lj
093	11.8	Jo
094	12.7	Lj
096	12.5	Ch
101	12.6	Lj
113	12.4	Lj
117	11.6	Pt
119	11.7	Ah
119	11.7	Lj
121	11.6	Lj
125	11.4	Ah
126	11.3	Lj
127	11.1	Lj
128	11.3	Ah
130	10.7	Jo
V Lib		
143417		
083	13.5	L
114	13.5	L
120	13.8	B
S Lup		
144646a		
092	10.8	En
U Boo		
144918		
089	10.5	Bw
093	10.7	B

J.D.	Est.	Obs.
U Boo		
144918		
096	11.2	Ch
100	10.9	BL
103	11.0	BL
104	10.9	BL
106	11.0	BL
110	10.5	B
112	11.0	BL
113	10.9	BL
118	10.7	BL
119	10.8	BL
122	10.6	BL
124	10.7	BL
127	10.5	BL
129	10.8	BL
131	11.1	BL
141	10.9	BL
Y Lup		
145254		
056[	12.4	Sm
065[	13.4	En
093[	13.7	En
118[	13.7	Bl
S Aps		
145071		
039	10.8	En
055	10.6	Sm
058	10.6	Sm
061	10.7	Ht
065	10.7	En
067	10.7	Ht
070	10.5	Dr
073	10.5	Dr
071	10.8	Bl
077	10.4	Dr
079	10.7	Bl
082	10.4	Dr
084	10.7	Ht
088	10.8	Ht
089	10.4	Dr
092	10.6	En
093	10.6	Ht
095	10.4	Bl
096	10.5	Dr
097	10.5	En
112	10.7	Bl
118	10.4	Bl
RT Lib		
150018		
086	11.6	Pt
117	9.0	Pt
118	9.2	B
120	9.6	Sf
127	9.5	Sf
127	8.9	HS
141	9.5	Sf
142	9.1	HS

J.D.	Est.	Obs.
T Lib		
150519		
093	12.2	L
096	11.8	Ch
114	11.0	L
117	11.5	Pt
120	11.8	B
Y Lib		
150605		
077	8.1	L
086	8.7	Pt
091	8.3	L
114	9.0	L
117	9.4	Pt
118	9.0	Sf
124	9.2	Jo
124	9.7	B
124	9.5	Sf
128	9.1	Jo
141	10.7	Sf
S Lib		
151520		
074	9.2	Ch
074	9.6	L
086	9.8	Pt
090	9.3	L
114	9.2	L
117	8.9	Pt
S Ser		
151714		
084	14.0	L
086	13.8	Br
093	14.2	L
113	13.1	B
114	13.4	L
126	12.9	Br
131	12.9	BE
145	12.3	Md
S CrB		
151731		
068	11.9	Ch
086	12.1	Pt
086	12.0	Br
096	12.4	Ch
100	12.6	B
117	12.8	Pt
118	13.3	B
126	13.3	Br
RS Lib		
151822		
039	8.3	Ht
061	8.6	Ht
067	8.7	Ht
071	8.5	Bl
077	8.6	L
079	8.7	Bl
088	9.5	Ht
091	9.9	L
093	9.8	Ht
093	10.2	En

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS LIB	S UMI	R CRB	R CRB	X CRB	RR LIB
151822	153378	154428	154428	154536	*155018*
095 9.8 Bl	107 9.7 Lg	089 6.2 Lj	117 6.0 L	101 9.6 Sf	128 12.1 Ma
112 10.5 Bl	113 10.4 Lj	089 6.4 Ah	117 6.2 Fd	110 9.9 B	Z CRB
114 11.2 L	113 10.0 Sf	090 6.1 Pt	117 6.2 Pt	113 10.0 Sf	155229
118 11.1 Bl	116 10.4 Lj	090 6.2 Ah	118 6.0 L	115 10.1 L	069 13.6 L
120 11.3 B	117 9.4 Pt	090 6.0 L	118 6.0 Jo	117 10.1 BE	086 13.8 Br
RU LIB	118 9.8 Sf	091 6.1 Fd	118 6.1 Pt	118 9.9 Ma	091 14.0 L
152714	119 10.1 Lj	091 6.1 Pt	118 6.0 Ah	119 10.4 Sf	116 14.0 L
077 9.1 L	121 10.0 Lj	091 5.9 L	118 6.1 Wd	119 10.4 Pt	146 12.5 Md
086 9.0 Pt	124 9.3 Jo	092 6.2 Lj	119 6.2 Lj	124 10.6 Sf	RZ SCO
091 9.3 L	124 9.7 Sf	092 6.3 Ah	119 6.0 HS	126 10.5 Br	*155823*
096 9.9 Ch	126 9.7 Lj	093 6.1 Pt	119 6.1 Ah	128 10.3 Ma	039 11.2 Ht
114 10.9 L	128 9.3 Jo	093 5.9 Tf	119 6.2 Fd	142 11.1 Ma	061 12.2 Ht
117 10.2 Pt	130 9.2 Jo	093 6.5 HS	119 6.1 Pt	R SER	067 12.1 Ht
124 11.5 B	U LIB	093 6.2 Wd	121 6.2 Lj	154615	086 10.0 Pt
R NOR	*153620a*	093 6.2 Ch	121 6.0 Be	081 10.4 Jo	088 10.0 Ht
152849	095[12.9 Bl	093 6.0 Jo	121 6.2 Pt	084 11.0 Md	093 9.5 Ht
039 12.5 Ht	118[13.4 Bl	093 6.0 L	122 6.0 HS	086 10.5 Pt	093 9.3 En
061 12.5 Ht	T NOR	094 6.2 Lj	122 6.0 Ah	086 10.9 Br	119 8.1 Pt
067 12.6 Ht	*153654*	095 6.0 Gy	122 6.0 Gb	087 10.7 Jo	Z SCO
070 12.7 Dr	039 13.0 Ht	095 6.3 Ah	122 6.2 Pt	090 10.9 Ch	*160021*
071 12.6 Bl	056[12.2 Sm	096 6.3 Ah	123 6.2 Pt	095 11.2 Jo	039 12.0 Ht
088 12.6 Ht	067[13.1 Ht	096 6.0 Jo	123 5.9 Wd	097 11.3 Md	077 12.0 L
089 12.9 Dr	088[12.8 Ht	097 6.0 L	124 5.9 Jo	113 11.8 B	088 11.3 Ht
093 13.0 Ht	089 12.6 Dr	097 6.2 Lj	124 6.0 Ah	119 12.0 Pt	093 12.0 Ht
095 12.9 Bl	093 12.8 Ht	097 5.9 Tf	124 6.1 Pt	126 12.3 Br	095 11.9 Bl
118 12.6 Bl	093 12.8 En	098 6.2 Pt	125 6.2 Pt	126 12.6 Md	096 12.0 L
X LIB	Z LIB	099 6.2 Pt	125 6.2 Lj	145 12.8 Md	112 11.4 Bl
153020	*154020*	099 6.2 Fd	125 6.0 Ah	V CRB	116 11.6 L
095[12.9 Bl	089[13.6 Dr	099 6.2 Ah	126 6.1 Lj	154639	118 11.5 Bl
118 11.5 Bl	095[12.7 Bl	099 6.0 Be	126 6.0 Be	083 10.5 Md	R HER
W LIB	118[12.7 Bl	100 6.2 Pt	127 6.1 Lj	086 9.7 Pt	160118
153215	R CRB	100 6.5 HS	127 6.0 Ah	091 10.3 Bw	082 9.7 Jo
095 12.0 Bl	154428	100 6.2 Wd	127 6.1 Fd	097 10.2 Md	086 9.9 Pt
096 12.0 Ch	068 6.2 Lj	100 6.3 Ah	127 6.1 Wd	106 9.8 Bw	086 10.4 Br
112 11.0 Bl	068 6.2 Ch	101 6.2 Pt	127 6.1 Pt	107 8.3 Lg	086 10.1 Fd
114 11.4 L	068 5.9 Ah	101 6.2 Lj	128 6.1 Pt	110 9.1 B	087 9.9 Jo
118 11.1 Bl	069 6.0 L	102 6.2 Pt	128 6.2 Lj	119 9.1 Pt	089 10.2 Fd
124 11.1 B	074 5.9 L	102 6.2 Lj	128 6.0 HS	126 9.3 Md	091 9.9 Fd
S UMI	076 6.0 Ch	102 6.2 Ah	128 6.0 Ah	143 8.8 Md	091 10.3 Sf
153378	077 6.1 L	103 6.2 Pt	129 6.2 Pt	R LIB	091 10.6 Sw
068 11.7 Lj	077 5.9 Tf	103 5.9 Jo	130 6.2 Pt	*154715*	092 10.7 Fd
082 11.5 Jo	079 6.0 L	103 5.9 L	130 6.2 Wd	116 14.0 L	093 10.4 Jo
086 10.8 Pt	080 6.2 Sw	104 6.1 Pt	130 6.0 Jo	120 13.7 B	096 11.0 Jo
087 11.4 Sf	081 6.1 Pt	105 6.1 Pt	131 6.0 HS	R LUP	099 10.8 Fd
087 10.6 Jo	081 5.8 Jo	106 6.1 Pt	132 5.9 Wd	*154736*	100 10.6 Fd
089 11.5 Lj	083 6.1 L	106 6.1 Wd	132 6.1 Pt	070 13.0 Dr	117 12.1 B
090 11.2 Ch	086 6.2 Pt	109 5.9 Wd	138 6.1 Pt	089 13.4 Dr	119 12.4 Pt
092 11.4 Lj	086 6.1 Ma	110 6.0 Be	142 6.0 Gb	RR LIB	121 12.3 Fd
093 11.4 Sf	087 6.0 Gy	112 6.0 L	142 6.2 HS	*155018*	126 12.5 Br
093 10.3 Jo	087 6.2 Wd	112 6.2 Lj	146 6.0 Mg	070 8.7 Dr	U SER
094 11.4 Lj	087 6.2 Lj	113 6.2 HS	X CRB	077 9.3 L	160210
096 10.0 Jo	087 6.1 Ah	113 6.0 Jo	154536	086 9.9 Pt	086 12.3 Pt
097 11.2 Lj	087 6.0 Jo	113 6.0 Ah	077 10.0 L	089 9.6 Dr	086 11.8 Br
098 9.9 Gy	088 6.0 Gb	113 6.0 Wd	086 9.7 Pt	091 9.6 L	091 12.1 Fd
099 10.9 Fd	088 6.2 Ah	114 6.0 L	086 9.3 Br	116 12.1 L	099 11.6 Fd
100 10.0 B	088 6.0 L	116 6.2 Lj	089 9.6 Sf	119 12.2 Pt	107 9.7 Lg
100 11.0 Sf	089 5.2 Fd	116 6.0 L	091 9.5 L	120 12.5 B	118 9.3 B
101 11.2 Lj	089 6.2 Pt	116 6.0 Ah	092 9.8 B	127 13.3 Bw	119 9.2 Fd

Variable Star Observations Received During May and June, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U Ser	RU Her	V Oph	T Oph	R Dra	S Her
160210	160625a	*162112*	*162815*	163266	164715
119 9.0 Pt	090 12.7 L	074 9.2 Ch	116 11.4 L	094 8.1 Ah	068 11.2 Ch
120 9.2 Ma	116 13.2 L	077 8.0 L	118 11.2 Bl	095 8.1 Ah	074 10.8 Ch
121 8.5 Fd	117 13.1 B	091 8.4 Pt	121 11.5 Pt	095 8.0 Jo	099 9.5 Pt
125 9.0 Bc	119 12.8 Pt	096 8.6 L	129 11.8 Bw	095 7.9 Gy	099 9.4 Ah
126 9.1 Br	128 13.0 BE	116 8.9 L	S Oph	097 8.1 Lj	100 9.6 Ah
127 8.4 Fd	R Sco	121 9.0 Pt	*162816*	098 8.1 Gy	110 8.9 B
128 8.6 Ma	*161122a*	124 10.0 B	069 14.3 L	099 7.9 Pt	113 9.0 Ah
142 8.4 Ma	061 12.6 Ht	U Her	090 12.7 L	099 8.1 Ah	116 8.9 Ah
X Sco	067 12.4 Ht	162119	095 11.9 Bl	099 7.9 Fd	119 8.9 Ah
160221a	071 12.2 Bl	074 11.2 Ch	112 10.4 Bl	100 8.1 Fd	120 9.0 Jo
071 12.8 Bl	086 10.7 Pt	082 11.6 Jo	116 10.2 L	100 8.1 HS	121 9.3 Bc
095 12.1 Bl	088 10.1 Ht	086 11.2 Br	118 9.8 Bl	100 7.8 Ma	121 8.8 Pt
118 11.4 Bl	090 10.3 Nz	087 11.5 Jo	W Her	100 8.1 Ah	122 8.8 Ah
SX Her	093 10.1 Ht	089 11.3 Fd	163137	101 8.2 Lj	124 8.7 Ah
160325	093 10.2 En	091 11.8 Fd	068 11.2 Ch	103 8.3 Jo	125 8.8 Ah
069 8.5 L	095 9.9 Bl	091 11.8 Sw	082 11.6 Jo	113 8.8 Lj	127 8.8 Ah
081 8.0 Pt	112 9.7 Bl	092 11.8 Fd	086 12.0 Fd	113 8.4 Jo	127 9.2 Jo
086 8.0 Pt	118 10.4 Bl	093 11.8 Jo	086 11.5 Br	113 8.3 HS	128 8.8 Ah
089 8.1 Pt	121 10.3 Pt	096 12.0 Jo	087 11.8 Jo	113 8.4 Ah	130 9.0 Jo
090 8.0 Pt	S Sco	099 11.4 Fd	089 11.2 Fd	116 8.5 Ah	RS Sco
090 8.2 L	*161122b*	099 11.4 Pt	091 11.3 Fd	116 8.9 Lj	*164844*
091 8.2 Pt	061[12.6 Ht	100 11.5 Fd	092 11.5 Fd	117 8.2 Fd	039 11.8 Ht
093 8.0 Pt	071[13.0 Bl	117 11.5 B	099 12.6 Pt	118 9.0 Wd	061 11.6 Ht
098 8.0 Pt	090 14.3 Nz	117 11.7 Fd	113 13.1 B	118 9.1 Ma	067 10.9 Ht
099 7.8 Pt	093[12.6 En	119 12.4 Fd	122 13.4 Pt	119 8.4 HS	070 10.0 Dr
100 7.9 Pt	095[13.0 Bl	121 11.5 Fd	R UMi	119 8.8 Ah	071 10.5 Bl
101 7.9 Pt	118 12.5 Bl	121 11.8 Pt	163172	119 9.3 Lj	079 10.2 Bl
102 7.9 Pt	121 11.9 Pt	Y Sco	082 9.2 Jo	121 9.3 Lj	082 10.0 Dr
103 7.9 Pt	W CrB	*162319*	087 9.2 Jo	121 8.9 Pt	088 10.4 Ht
104 8.0 Pt	161138	069 13.1 L	093 9.2 Jo	122 9.3 HS	089 9.9 Dr
105 8.0 Pt	081 9.8 Jo	090 11.6 L	110 9.4 B	122 9.8 Ah	093 10.4 Ht
106 7.9 Pt	086 10.1 Br	116 11.3 L	113 9.0 Jo	123 9.1 Wd	093 10.2 En
114 7.7 L	087 10.0 Jo	129 11.5 Bw	124 8.9 Jo	124 9.4 Jo	095 10.0 Bl
117 8.0 Pt	088 10.2 Md	SS Her	124 9.5 B	124 9.2 Ah	112 8.4 Bl
118 8.0 Pt	089 9.9 Sf	162807	128 8.8 Jo	125 9.2 Ah	118 7.7 Bl
119 8.0 Pt	092 10.3 Fd	077 11.6 L	R Dra	126 9.3 Lj	145 6.7 Mg
121 8.0 Pt	095 10.1 Jo	086 10.7 Br	163266	127 9.3 Wd	RR Sco
122 8.0 Pt	099 10.2 Pt	091 10.3 L	063 7.8 Ch	127 8.7 Fd	*165030a*
123 8.1 Pt	101 10.5 Sf	099 10.0 Pt	068 7.8 Ah	128 9.4 Ah	061 11.3 Ht
124 8.1 Pt	103 10.1 Jo	107 10.0 Lg	068 7.8 Lj	128 9.3 HS	067 11.0 Ht
125 8.1 Pt	113 10.6 Md	110 10.0 B	069 7.6 Lj	128 9.3 Ma	070 10.3 Dr
127 8.1 Pt	113 10.8 Sf	114 10.3 L	082 7.4 Jo	130 9.5 Ma	071 10.3 Bl
128 8.2 Pt	118 10.4 B	120 10.1 Sf	086 7.4 Fd	130 9.9 Wd	088 8.8 Ht
129 8.2 Pt	119 10.8 Fd	120 9.0 Jo	086 7.5 Br	130 9.6 Jo	089 8.9 Dr
130 8.3 Pt	119 11.0 Sf	121 9.6 Bc	087 7.7 Ah	131 9.5 HS	093 8.8 Ht
132 8.1 Pt	121 10.8 Fd	121 10.3 Pt	087 7.7 Jo	132 10.0 Wd	093 8.5 En
138 8.2 Pt	121 10.9 Pt	124 10.3 Sf	087 7.5 Gy	142 10.0 Ma	095 8.8 Bl
W Sco	124 11.4 Sf	129 10.9 Jo	088 7.8 Ah	142 10.0 HS	112 7.5 Bl
160519	134 11.2 Md	T Oph	089 7.9 Ah	RR Oph	118 7.1 Bl
089[13.8 Dr	143 11.4 Md	*162815*	089 7.5 Fd	*164319*	SS Oph
095[13.4 Bl	W Oph	070 9.8 Dr	089 8.0 Lj	090 14.8 Nz	*165202*
118 12.8 Bl	*161607*	071 9.8 Bl	090 7.9 Ah	096 14.5 L	099 11.3 Pt
RU Her	077 11.9 L	077 10.1 L	091 7.7 Fd	099 13.5 Pt	121 9.0 Pt
160625a	091 11.2 Pt	089 10.3 Dr	092 7.8 Fd	119 12.3 L	123 8.9 Md
068 12.2 Ch	097 10.7 L	095 10.2 Bl	092 7.9 Lj	121 12.1 Pt	143 8.8 Md
069 11.9 L	116 10.4 L	096 10.6 L	093 7.7 HS	145 11.7 Mg	RV Her
086 12.4 Pt	121 10.6 Pt	099 10.7 Pt	093 7.7 Jo		165631
086 12.7 Br		112 10.7 Bl	094 8.1 Lj		077 9.8 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.

RV HER
165631
082 10.6 Jo
086 11.0 Br
087 11.2 Jo
090 11.5 L
093 11.5 Jo
095 11.8 Bw
096 12.0 Jo
099 11.8 Pt
106 12.6 Bw
107 12.0 Lg
114 12.7 L
117 13.2 B

RT SCO
165636
093[12.1 En
095[14.0 Bl
118[14.0 Bl

— DRA
165752
073[14.5 L

R OPH
170215
077 8.5 L
081 8.5 Jo
087 8.4 Jo
093 8.2 Jo
095 8.1 Jo
096 7.7 L
099 7.8 Pt
100 8.3 Fd
113 8.0 Jo
116 7.5 L
118 8.0 Jo
119 8.1 Fd
121 8.1 Fd
121 7.8 Pt
124 8.0 B
125 7.6 Bc
127 8.0 Jo
127 8.4 Fd

RT HER
170627
069 12.0 L
086 12.8 Br
091 12.9 L
116 13.4 L
117 13.9 B
126 14.0 Br

RW SCO
170833
095[13.0 Bl
118[13.0 Bl

Z OPH
171401
099 12.7 Pt
120 13.3 B
121 12.8 Pt

J.D.Est.Obs.

RS HER
171723
086 8.4 Br
095 9.1 Bw
099 8.6 Pt
106 9.6 Bw
121 10.5 Pt
131 11.6 Bw
134 11.5 Md

S OCT
172486
055 11.3 Sm
060 11.7 Ht
067 12.0 Ht
070 11.8 Dr
071 11.9 Bl
083 12.6 Ht
088 12.8 Ht
089 12.7 Dr
093 12.9 Ht
095 12.9 Bl
118 13.5 Bl

RU OPH
172809
077 9.1 L
086 9.2 Br
090 9.1 L
099 9.1 Pt
114 10.8 L
117 11.1 BE
121 11.0 Pt
126 11.4 Br
130 11.5 Ma
142 11.9 Ma
151 12.8 Md

RT SER
173411
096 12.1 L
116 12.2 L

RU SCO
173543
070 11.0 Dr
089 11.0 Dr
095 12.6 Bl
118 11.6 Bl

SV SCO
174135
070 12.4 Dr
071 13.0 Bl
095[12.7 Bl
118[13.0 Bl

W PAV
174162
071[13.0 Bl
093[13.0 Ht
118[13.0 Bl

RS OPH
174406
121 11.1 Pt

J.D.Est.Obs.

U ARA
174551
061 12.3 Ht
067 12.2 Ht
070 11.5 Dr
088 9.3 Ht
089 9.0 Dr
093 8.5 Ht

RT OPH
175111
069 10.4 L
086 11.9 Br
091 11.8 L
099 11.1 Pt
100 12.2 Bw
116 12.1 L
126 12.3 Br
130 12.6 Bw

RY HER
175519
069 14.0 L
086 13.3 Br
091 13.4 L
095 13.0 Bw
099 12.4 Pt
107 11.7 Bw
116 11.1 L
117 10.7 B
121 10.5 Pt
126 9.8 Br
130 9.1 Ma
131 9.2 Bw
142 9.0 Ma

V DRA
175654
069 9.4 L
086 9.8 Br
088 9.8 Md
091 9.6 L
095 9.5 Jo
115 11.5 L
121 11.7 Pt
123 11.9 Md
126 12.5 Br

R PAV
180363
061 12.5 Ht
067 12.5 Ht
088 11.0 Ht
093 10.4 Ht

T HER
180531
077 12.7 L
091 13.5 L
099 13.4 Pt
114 12.8 L
121 11.5 Fd
121 12.0 Pt
124 11.5 Ah
124 12.0 Jo

J.D.Est.Obs.

T HER
180531
130 11.6 Jo

W DRA
180565
073 11.4 L
087 10.2 Br
091 10.5 L
099 10.4 Pt
115 10.0 L
121 10.1 Pt
126 9.8 Br

X DRA
180666
087 11.3 Br
115 14.0 L
126 13.3 Br

NOV OPH
180911
121[13.0 Pt

TV HER
181031
077 10.5 L
091 10.7 L
116 11.3 L

RX OPH
181103
099 7.2 Pt
099 8.1 Ah
100 8.0 Ah
113 8.1 Ah
118 8.3 Ah
119 8.9 Ah
121 8.2 Pt
122 8.8 Ah
124 9.0 Ah
125 9.4 Ah
127 9.3 Ah
128 9.5 Ah
146 12.2 Md

W LYR
181136
078 11.2 L
081 12.0 Jo
087 11.9 Jo
093 11.8 Jo
096 10.6 L
099 10.1 Pt
113 9.4 Ah
114 9.0 L
116 8.9 Ah
118 9.4 Jo
119 9.0 Ah
120 9.0 Sf
121 8.9 Pt
122 8.9 Ah
124 8.8 Ah
124 8.7 Jo
125 8.8 Ah
127 8.8 Ah

J.D.Est.Obs.

W LYR
181136
127 8.8 Jo
127 9.0 Sf
130 8.8 Jo
133 8.3 Wd
141 8.3 Sf

RV SGR
182133
070 10.5 Dr
089 9.9 Dr
095 9.7 Bl
112 8.0 Bl
118 7.8 Bl

SV HER
182224
069 10.1 L
091 10.8 L
099 11.3 Pt
100 11.3 Bw
116 12.7 L
121 12.8 Pt
126 13.4 Br
130 13.5 Bw

T SER
182306
101 12.4 Bw
130 12.2 Bw

SV DRA
183149
078 9.9 L
087 10.0 Br
097 10.8 L
100 11.5 Ma
117 12.0 L
126 12.0 Br

RZ HER
183225
078 9.0 L
091 9.4 L
116 10.4 L
126 10.9 Br

X OPH
183308
077 8.2 L
087 8.0 Jo
091 7.8 L
095 8.0 Jo
099 7.5 Pt
113 8.0 Jo
116 7.5 L
118 7.6 Jo
121 7.4 Fd
121 7.5 Pt
124 7.4 Jo
127 7.6 Fd
130 7.2 Jo

RY LYR
184134
073 12.2 L

J.D.Est.Obs.

RY LYR
184134
096 10.3 L
099 10.0 Pt
113 9.3 Jo
116 9.8 L
118 9.5 Jo
120 11.8 Ma
121 9.5 Pt
126 10.0 Br
127 10.0 Jo
130 10.5 Jo
130 13.1 Ma

R SCT
184205
071 6.0 Gb
073 5.3 L
076 5.6 Ch
078 5.2 L
086 5.7 Pt
087 5.6 Jo
088 5.2 L
093 5.3 Pt
095 5.5 Gy
095 5.7 Jo
096 5.0 L
099 5.6 Gy
099 5.9 Pt
099 6.2 Fd
100 6.3 Fd
100 5.8 Pt
100 5.5 Ma
101 5.7 Lj
102 5.8 Pt
104 6.0 Pt
105 5.9 Pt
107 5.8 Lg
113 5.9 Lj
113 6.5 Jo
114 5.8 L
116 5.9 Lj
118 6.1 Jo
118 5.8 Ma
118 6.1 Pt
119 6.0 Pt
119 6.7 Lj
120 6.3 Ma
121 6.8 Lj
121 6.2 Pt
121 6.0 Fd
122 6.1 Pt
123 6.7 Wd
125 6.4 Pt
125 6.5 Bc
125 6.7 Lj
126 6.8 Lj
126 6.5 Bc
127 6.7 Bc
127 6.9 Lj
127 6.3 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R SCT	Z LYR	X LYR	RY SGR	AF CYG	T PAV
184205	185634	190926	*191033*	192745	*193972*
127 6.2 Fd	117 14.0 L	121 8.8 Pt	104 12.5 Pt	128 6.9 Ah	061 11.7 Ht
127 7.0 Wd	126 13.5 Br	RS LYR	105 12.0 Pt	TY CYG	067 12.0 Ht
127 6.5 Gb	SU SGR	190933a	116 12.2 L	192928	071 12.0 Bl
128 6.3 Ma	*185722*	073 10.5 L	117 12.2 L	009 9.4 L	088 13.0 Ht
128 6.7 Bc	067 8.4 Ht	096 10.3 L	118 12.3 L	071 11.0 Ch	093 13.2 Ht
128 6.6 Pt	093 8.4 Ht	099 10.7 Pt	121 12.2 Pt	073 11.1 L	095 13.5 Bl
129 6.5 Pt	RT LYR	106 10.5 Bw	122 12.0 Pt	099 9.2 Pt	118[13.2 Bl
130 6.5 Pt	185737	117 11.3 L	128 12.5 Pt	117 9.5 L	RT CYG
130 6.5 Ma	073 12.7 L	121 11.1 Pt	130 13.0 Pt	121 8.8 Pt	*194048*
130 6.6 Gb	096 13.6 L	131 11.7 Bw	TY SGR	RT AQL	082 11.7 Jo
130 6.5 Jo	117 14.6 L	RU LYR	*191124*	193311	086 9.3 Fd
130 6.9 Wd	R AQL	190941	070 9.6 Dr	078 14.1 L	087 11.5 Jo
132 6.5 Ma	190108	073 14.1 L	089 10.1 Dr	100 14.3 L	089 10.0 Ah
132 6.5 Pt	068 7.6 Ah	U DRA	118 11.4 Bl	118 14.1 L	090 10.0 Ah
133 6.8 Wd	090 8.3 Ah	190967	S SGR	R CYG	091 9.5 Fd
138 6.2 Ma	091 8.2 Ah	073 13.7 L	*191319a*	193449	092 9.7 Ah
139 5.7 Ma	092 8.4 Ah	099 14.3 L	093 12.2 Ht	082 12.0 Jo	094 9.5 Ah
142 6.3 Ma	094 8.4 Ah	099 14.5 Pt	099 13.5 Pt	087 11.8 Jo	095 9.3 Ah
143 6.3 Ma	099 7.6 Pt	118 14.3 L	118[12.9 Bl	090 11.5 Ah	095 9.3 Jo
144 6.5 Mc	099 8.5 Ah	121 14.0 Pt	— SGR	091 11.5 Fd	096 9.2 Ah
146 5.8 Mg	100 8.4 Ah	T SGR	*191319b*	095 10.2 Jo	099 9.1 Ah
147 6.3 Ku	113 8.6 Ah	*191017*	099 12.6 Pt	099 10.8 Ah	099 9.0 Fd
Nov AQL	116 8.8 Ah	073 10.9 L	SW SGR	099 10.5 Fd	099 8.9 Pt
184300	119 8.8 Ah	096 11.2 L	*191331*	099 10.1 Pt	100 9.1 Fd
086 11.7 Pt	121 8.6 Pt	099 11.6 Pt	118 12.9 Bl	100 10.3 Fd	100 9.1 Ah
093 11.6 Pt	122 9.0 Ah	116 11.7 L	TZ CYG	103 10.1 Wd	113 8.1 Ah
099 11.7 Pt	124 9.0 Ah	121 12.4 Pt	191350	113 9.7 Jo	113 7.7 Jo
100 10.6 Ma	125 9.2 Ah	R SGR	099 9.3 Pt	113 9.9 Ah	116 8.2 Ah
104 11.6 Pt	RX SGR	*191019*	121 10.7 Pt	116 9.9 Ah	118 8.0 Ah
118 11.6 Pt	*190818*	077 11.6 L	U LYR	118 9.9 Ah	118 7.5 Jo
120 10.7 Ma	078 11.2 L	093 10.4 Ht	191637	118 9.7 Jo	119 8.0 Ah
121 11.7 Pt	093 10.6 Ht	096 10.7 L	091 11.1 Fd	118 10.1 Wd	119 8.1 Fd
128 11.6 Pt	096 10.5 L	099 10.1 Pt	099 10.8 Fd	119 9.7 Fd	121 7.6 Fd
132 11.7 Pt	099 10.4 Pt	116 9.0 L	099 10.2 Pt	119 9.8 Ah	122 7.9 Ah
RX LYR	116 9.9 L	121 8.7 Pt	100 10.2 Fd	121 8.8 Fd	124 7.8 Ah
185032	121 9.6 Pt	RY SGR	119 10.9 Fd	122 9.6 Ah	124 7.7 Pt
126[13.9 Br	130 10.0 Ma	*191033*	121 9.6 Pt	123 9.4 Wd	124 7.6 Jo
S CRA	143 10.1 Ma	067 8.1 Ht	121 10.9 Fd	124 9.5 Ah	125 7.8 Ah
185437a	RW SGR	068 8.7 Ch	127 10.3 Fd	124 9.1 Jo	127 7.7 Ah
067 11.4 Ht	*190819a*	069 8.7 L	AF CYG	124 8.9 Pt	127 7.5 Jo
088 12.1 Ht	077 9.8 L	071 8.7 Ch	192745	125 9.2 Ah	127 7.0 Wd
093 11.4 Ht	093 9.6 Ht	073 8.7 L	068 7.8 Ah	127 9.1 Ah	127 7.7 Fd
095 11.7 Bl	096 9.6 L	076 8.8 Ch	089 7.5 Ah	127 8.4 Fd	128 7.5 Ah
118 11.6 Bl	099 9.2 Pt	077 8.6 L	090 7.6 Ah	127 8.6 Jo	TU CYG
ST SGR	116 9.4 L	078 8.6 L	092 7.2 Ah	127 9.2 Wd	194348
185512a	121 9.0 Pt	081 8.6 L	094 7.2 Ah	128 8.9 Ah	071 10.9 Ch
117[14.0 L	130 9.4 Ma	083 8.6 L	095 7.1 Ah	130 8.9 Wd	074 10.8 L
R CRA	143 9.8 Ma	088 9.0 L	096 7.1 Ah	132 8.8 Wd	099 9.4 L
185537a	BH SGR	088 9.2 Ht	099 7.1 Ah	132 8.2 Ma	099 8.9 Pt
067 12.5 Ht	*190819b*	090 9.2 L	100 7.0 Ah	133 8.6 Wd	100 9.1 Ma
088 12.5 Ht	076 12.2 L	093 9.4 Ht	113 6.5 Ah	RV AQL	118 9.4 L
093 12.5 Ht	TY AQL	096 10.5 L	116 6.5 Ah	193509	120 9.4 Ma
118 12.2 Bl	*190907*	099 12.5 Pt	118 6.6 Ah	074 11.8 L	124 9.6 Pt
T CRA	099 10.5 Pt	100 11.8 Pt	119 6.7 Ah	099 13.5 Pt	132 9.4 Ma
185537b	121 10.3 Pt	100 12.3 L	122 6.6 Ah	100 13.0 L	X AQL
067[12.5 Ht	X LYR	101 12.5 L	124 6.7 Ah	118 13.0 L	194604
095[12.5 Bl	190926	102 11.7 Pt	125 6.9 Ah		100 14.4 L
118 13.0 Bl	099 8.9 Pt	103 12.8 L	127 6.9 Ah		118 14.6 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
χ CYG	S TEL	RS CYG	U CYG	T DEL	X CEP
194632	*195855*	200938	201647	204016	210382
082 11.5 Jo	067 12.8 Ht	099 7.9 Fd	118 10.7 Jo	081 10.7 L	099 13.9 L
087 11.0 Jo	093 13.0 Ht	100 7.5 Fd	119 11.6 Fd	100 11.8 L	RS AQR
089 9.8 Ah	SY AQL	100 7.7 Pt	121 11.4 Fd	100 12.2 Pt	*210504*
095 10.0 Ah	200212	101 7.9 L	124 9.5 Pt	118 12.2 L	088 10.5 L
095 10.7 Jo	078 12.7 L	113 8.5 Jo	127 10.7 Fd	128 12.8 Pt	103 10.1 L
096 10.0 Ah	100 14.0 L	117 8.0 L	127 10.5 Jo	V AQR	Z CAP
113 10.1 Jo	100 13.4 Pt	118 8.5 Jo	130 10.5 Jo	204102	*210516*
118 9.9 Jo	118 14.5 L	119 8.4 Fd	U MIC	088 9.1 L	097 13.3 Nz
120 12.2 Ma	BU CYG	121 8.1 Fd	*202240*	100 8.3 Pt	R EQU
127 9.7 Jo	200250	124 8.2 Pt	082 11.2 Dr	103 8.6 L	210812
130 9.8 Jo	113 12.1 Lj	127 6.9 Wd	RU CAP	118 8.3 L	081 11.9 L
132 11.1 Ma	119 12.0 Lj	127 8.1 Fd	*202622*	128 8.0 Pt	097 13.9 Nz
148 10.7 Pt	121 11.7 Lj	127 8.2 Jo	097 02.3 Nz	W AQR	100 13.1 Ma
S PAV	125 11.2 Lj	130 8.6 Jo	Z DEL	*204104*	101 13.6 L
194659	126 10.9 Lj	147 8.7 Ku	202817	088 11.4 L	120[12.2 Ma
082 7.7 Dr	S CYG	R DEL	100 13.4 L	097 11.0 Nz	132[12.9 Ma
RR SGR	200357	201008	118 12.5 L	103 10.5 L	T CEP
194929	078 12.2 L	078 8.6 L	120 13.0 Ma	118 9.5 L	210868
082 6.9 Dr	099 13.3 L	100 9.4 Pt	128 11.7 Pt	U CAP	068 9.4 Ah
RU SGR	100 13.4 Pt	100 9.2 L	132 11.5 Ma	*204215*	076 9.5 Ch
195142	118 13.8 L	117 9.5 L	ST CYG	088[11.5 L	082 9.3 Jo
067 7.6 Ht	R CAP	124 10.0 Pt	202954	103 14.5 L	086 9.2 Fd
082 7.6 Dr	*200514*	SX CYG	077 11.0 L	117[13.7 L	087 9.6 Jo
089 8.1 Dr	100 12.8 Pt	201130	099 10.9 L	V DEL	088 9.8 Sw
093 8.1 Ht	118 13.4 L	078 12.3 L	100 11.3 Pt	204318	090 10.2 Ah
RR AQL	128 12.6 Pt	099 11.7 L	118 10.8 L	081[13.1 L	091 9.3 Fd
195202	S AQL	100 11.4 Pt	124 10.8 Pt	100[13.1 Ma	092 9.5 Fd
088 13.0 L	200715a	107 12.1 Bw	V VUL	132[13.1 Ma	092 10.2 Ah
101 13.1 L	100 9.4 Pt	118 12.3 L	203226	T AQR	095 10.3 Ah
118 13.5 L	128 9.3 Pt	131 12.9 Bw	100 9.4 Pt	*204405*	095 10.2 Gy
RS AQL	RW AQL	WX CYG	128 8.6 Pt	100 13.5 Pt	095 9.9 Jo
195308	200715b	201437b	Y DEL	128 12.8 Pt	096 10.4 Ah
101 13.8 L	100 9.3 Pt	070 10.5 Ch	203611	RZ CYG	099 9.7 Fd
118 13.8 L	128 9.5 Pt	077 8.9 L	100 13.3 L	204846	099 10.4 Ah
NOV CYG	R TEL	087 10.0 Jo	118 14.1 L	100 13.0 Pt	100 10.4 Ah
195553	*200747*	090 8.8 L	132[12.5 Ma	124 13.3 Pt	100 9.9 Fd
086[12.2 Pt	082 9.9 Dr	095 10.3 Jo	S DEL	S IND	101 9.8 Pt
089[12.2 Pt	RU AQL	100 9.0 Pt	203816	*204954*	113 10.5 Ah
093[12.2 Pt	200812	101 8.6 L	092 11.1 Lj	093[13.5 Ht	116 10.6 Ah
099[12.2 Pt	078 13.1 L	113 10.9 Jo	094 11.1 Lj	X DEL	117 9.8 Fd
104[12.2 Pt	100 14.0 L	117 8.8 L	100 11.3 Pt	205017	118 10.0 Jo
118[12.2 Pt	118 14.1 L	118 10.7 Jo	102 11.1 Lj	081 9.7 L	119 10.0 Fd
124[12.2 Pt	Z AQL	127 10.5 Jo	116 10.5 Lj	100 10.7 Pt	119 10.6 Ah
128[12.4 Pt	*200906*	130 10.5 Jo	125 10.0 Lj	100 10.5 L	121 9.8 Fd
RR TEL	090 12.9 Nz	U CYG	126 9.9 Lj	118 10.7 L	122 10.7 Ah
195656	097 12.5 Nz	201647	128 9.1 Pt	124 11.4 Pt	124 10.7 Ah
067[12.6 Ht	100 10.9 Pt	071 10.5 Gb	V CYG	RR CAP	124 10.0 Pt
088[12.6 Ht	128 9.1 Pt	071 10.4 Ch	203847	*205627*	124 10.2 Jo
093[12.6 Ht	RS CYG	082 11.0 Jo	081 12.7 L	082 8.9 Dr	125 10.7 Ah
Z CYG	200938	086 11.2 Fd	099 12.1 L	R VUL	127 10.0 Fd
195849	067 8.2 Ch	087 11.2 Jo	100 11.9 Ma	205923a	128 10.6 Ah
078 9.1 L	071 8.2 Gb	091 11.4 Fd	118 12.0 L	100 11.6 Pt	130 10.2 Jo
099 8.7 L	071 8.3 Ch	092 11.6 Fd	120 11.9 Ma	124 12.6 Pt	RR AQR
100 9.0 Pt	077 7.9 L	095 11.6 Jo	124 12.7 Pt	TW CYG	*210903*
107 9.3 Lg	087 7.8 Jo	099 11.3 Fd	132 11.9 Ma	210129	089 11.1 L
118 9.8 L	090 7.9 L	100 11.6 Fd	Y AQR	081 12.8 L	103 12.5 L
124 10.5 Pt	091 7.9 Fd	100 10.0 Pt	*203905*	097 12.4 Nz	
	095 7.6 Jo	113 10.9 Jo	097 14.5 Nz	099 12.7 L	

Variable Star Observations Received During May and June, 1930.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Y Pav	S Cep	U Aqr	RV Peg	V Cas	RR Cas
211570	213678	*215717*	*222129*	230759	235053
067 5.7 Ht	124 9.8 Pt	101 13.1 L	083 11.2 L	090 9.5 Ah	089 11.3 Bn
093 6.4 Ht	130 10.1 Jo	128 13.6 Pt	101 12.0 L	095 9.5 Ah	115 10.5 Bn
X Peg	RU Cyg	RT Peg	S Lac	096 9.7 Ah	143 10.6 Bn
211614	213753	215934	*222439*	099 9.8 Ah	R Tuc
096 13.2 L	095 9.1 Ah	081[12.5 L	083 8.0 L	100 9.9 Fd	*235265*
100 12.7 Ma	096 8.6 Ah	101[13.5 L	101 7.9 L	102 9.8 Pt	039 11.0 En
101 12.0 Pt	099 9.0 Ah	RY Peg	102 8.2 Pt	121 9.9 Fd	055 12.6 Sm
117 11.2 L	100 9.0 Ah	220133a	128 8.8 Pt	125 10.5 Ah	R Cas
120 11.1 Ma	102 9.0 Pt	128 12.4 Pt	R Ind	127 11.2 Fd	235350
128 11.5 Pt	113 9.8 Ah	RZ Peg	*222867*	128 11.0 Pt	094 9.4 Ah
132 11.1 Ma	119 10.1 Ah	220133b	069 12.8 Bl	W Peg	096 9.2 Ah
T Cap	122 9.9 Ah	081 10.9 L	093[13.5 Ht	231425	099 9.6 Gy
211615	124 9.9 Ah	101 11.6 L	094[13.5 Bl	083 10.5 L	099 9.4 Ah
096 9.7 L	124 9.5 Pt	102 11.3 Pt	T Tuc	101 10.3 L	100 9.4 Fd
117 10.8 L	128 9.9 Ah	128 11.8 Pt	*223462*	S Peg	121 9.3 Fd
S Mic	131 10.0 Bw	T Peg	093 11.0 Ht	231508	122 9.8 Ah
212030	RV Cyg	220412	R Lac	117 8.2 L	124 9.7 Ah
082 8.6 Dr	213937	083 9.6 L	223841	128 8.5 Pt	125 9.9 Ah
Y Cap	102 6.3 Pt	101 9.5 L	103[14.0 L	Z And	127 9.6 Fd
212814	128 6.3 Pt	Y Peg	RW Peg	232848	128 9.8 Ah
096[13.1 L	RR Peg	220613	225914	102 10.3 Pt	Z Peg
W Cyg	214024	082 11.2 L	083 10.1 L	128 10.3 Pt	235525
213244	102 13.0 Pt	097 12.3 Nz	097 10.3 Nz	ST And	101 8.8 L
073 5.7 L	128 13.6 Pt	099 12.2 L	100 10.1 Ma	233335	102 8.9 Pt
088 5.6 L	R Gru	RS Peg	101 9.4 L	092 9.0 Lj	127 8.9 Lj
096 5.5 L	*214247*	220714	102 9.7 Pt	094 9.0 Lj	128 9.1 Pt
103 5.6 L	082 9.4 Dr	097 13.1 Nz	120 10.1 Ma	102 8.3 Pt	Y Cas
114 5.6 L	093 10.3 Ht	099 13.2 L	128 10.5 Pt	102 9.0 Lj	235855
S Cep	V Peg	128 11.5 Pt	132 10.8 Ma	116 9.0 Lj	117 11.8 L
213678	215605	X Aqr	R Peg	121 8.5 Fd	SV And
082 10.2 Jo	081 9.9 L	*221321*	230110	125 8.7 Lj	235939
095 10.0 Jo	101 10.0 L	097 9.2 Nz	102 11.3 Pt	127 8.8 Lj	102 7.8 Pt
101 8.6 Pt	102 9.9 Pt	S Gru	128 11.1 Pt	128 8.4 Pt	128 8.1 Pt
113 10.4 Jo	128 11.3 Pt	*221948*	V Cas	Z Cas	
124 10.2 Jo		082 12.7 Dr	230759	233956	
		093 12.5 Ht	068 8.9 Ah	117 13.4 L	

Rapidly Varying Irregular Variables.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
005840 RX Andromedae—					060547 SS Aurigae—				
	6099.9	11.1 Pt	6105.9	13.0 Pt		6090.3	14.7 L	6106.3	[12.4 L
	6100.9	11.9 Pt	6129.9	13.0 Pt		6091.1	[13.3 Ch	6107.6	[12.6 Bw
	6102.9	12.0 Pt	6130.9	12.4 Pt		6092.3	[14.5 L	6109.3	[12.4 L
	6104.9	12.6 Pt				6093.3	13.8 L	6110.3	[12.4 L
060547 SS Aurigae—						6096.7	[12.6 Br	6114.3	[13.3 L
	6062.1	[11.6 Ch	6081.7	12.0 Pt		6097.3	[14.5 L	6116.3	[12.4 L
	6068.4	14.8 L	6082.6	11.9 B		6098.7	[12.6 Pt	6117.7	[12.0 Pt
	6069.4	[13.9 L	6083.1	12.2 Nz		6099.7	[12.6 Pt	6119.7	[12.6 Pt
	6071.1	15.0 Nz	6083.3	12.2 L		6101.5	[13.0 Bw	6123.7	[12.6 Pt
	6072.3	[13.3 L	6083.6	12.3 B		6102.7	[12.6 Pt	6124.7	[12.6 Pt
	6073.3	[13.9 L	6084.1	12.7 Nz		6103.7	[12.0 Pt	6125.7	[12.4 Pt
	6077.3	[13.3 L	6084.4	13.0 L		6104.7	[12.0 Pt	6127.7	[12.4 Pt
	6078.3	[13.9 L	6084.7	12.9 Br		6105.7	[12.0 Pt	6130.7	[11.0 Pt
	6079.3	11.4 L	6085.3	13.5 L	074922 U Geminorum—				
	6080.1	10.8 Ch	6086.7	[13.3 Br		6062.2	[11.4 Ch	6071.1	14.1 Nz
	6080.7	11.3 Br	6088.3	14.2 L		6068.4	[13.7 L	6072.3	[13.3 L
	6081.3	11.2 L	6089.3	14.4 L		6069.3	[13.7 L	6073.1	[13.7 Nz

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
074922 U GEMINORUM—							202946 SZ CYGNI—						
	6077.3	13.3	L	6096.1	13.7	Ch		6104.9	9.4	Pt	6125.7	9.4	Pt
	6078.3	13.3	L	6097.3	13.9	L		6105.9	9.6	Pt	6127.7	9.0	Pt
	6079.3	13.3	L	6098.7	12.4	Pt		6118.8	9.5	Pt	6128.8	9.0	Pt
	6080.7	13.7	Br	6099.7	12.4	Pt		6119.7	9.6	Pt	6129.8	9.0	Pt
	6081.3	14.0	L	6102.7	10.1	Pt		6121.8	9.5	Pt	6130.7	9.2	Pt
	6082.6	13.8	B	6103.7	10.1	Pt		6122.8	9.5	Pt	6132.7	9.3	Pt
	6083.1	13.9	Nz	6105.7	12.0	Pt		6123.7	9.5	Pt	6138.7	9.6	Pt
	6083.3	14.1	L	6106.3	13.3	L		6124.7	9.5	Pt			
	6084.1	14.0	Nz	6109.3	13.3	L	213843 SS CYGNI—						
	6084.4	13.9	L	6110.6	13.5	B		6067.5	9.8	Ch	6114.6	11.3	L
	6084.7	14.0	Br	6112.3	14.2	L		6068.5	8.6	Ah	6115.6	11.3	L
	6085.3	14.1	L	6114.3	13.7	L		6068.6	8.7	Lj	6116.5	11.3	Ah
	6086.7	13.3	Ma	6116.3	14.1	L		6069.6	8.5	L	6116.6	11.5	Lj
	6088.3	13.7	L	6117.3	14.1	L		6073.6	8.9	L	6116.6	11.2	L
	6089.3	14.0	L	6117.7	12.4	Pt		6074.6	8.9	L	6117.6	11.5	L
	6090.7	12.4	Pt	6119.7	13.3	Pt		6076.4	8.2	Ch	6118.5	11.6	Ah
	6091.1	13.3	Ch	6121.6	13.7	B		6077.6	8.8	L	6118.6	11.3	L
	6092.3	13.7	L	6124.7	11.3	Pt		6078.6	8.8	L	6118.6	12.0	Jo
	6093.4	13.9	L	6130.7	10.0	Pt		6079.6	8.8	L	6118.8	11.7	Pt
	6093.6	14.0	B					6081.6	9.6	L	6118.9	11.0	Ma
081473 Z CAMELOPARDALIS—								6083.6	10.2	L	6119.4	11.5	Lj
	6068.4	12.1	L	6092.3	11.8	L		6086.7	12.0	Fd	6119.5	11.8	Ah
	6069.4	12.2	L	6093.4	11.5	L		6086.8	11.0	Ma	6119.6	11.9	Fd
	6072.3	12.4	L	6095.1	11.3	Ch		6086.9	11.7	Pt	6119.7	11.7	Pt
	6073.3	12.2	L	6096.3	11.8	L		6087.0	11.5	Br	6120.8	11.0	Ma
	6075.6	12.1	L	6097.3	11.5	L		6088.6	11.3	L	6121.4	11.6	Lj
	6077.3	12.4	L	6097.7	11.3	Br		6090.4	11.8	Ah	6121.6	11.8	Fd
	6078.3	12.8	L	6099.6	11.5	L		6091.5	11.5	Ah	6121.8	11.7	Pt
	6079.3	12.4	L	6101.3	11.4	L		6091.7	11.9	Fd	6122.4	11.8	Ah
	6080.7	11.2	Br	6103.6	11.3	L		6092.5	11.6	Lj	6122.8	11.7	Pt
	6081.3	11.0	L	6106.3	11.7	L		6092.5	11.6	Ah	6123.7	11.7	Pt
	6083.4	11.0	L	6109.3	11.6	L		6093.9	11.7	Pt	6124.4	11.8	Ah
	6084.4	11.3	L	6110.3	11.6	L		6094.5	11.5	Lj	6124.6	11.8	Jo
	6084.7	11.5	Br	6112.4	11.4	L		6094.5	11.8	Ah	6124.7	11.7	Pt
	6085.4	11.6	L	6114.4	11.3	L		6094.6	11.5	Lj	6125.4	11.8	Ah
	6086.8	11.3	Br	6115.6	11.3	L		6095.4	11.8	Ah	6125.6	11.7	Lj
	6088.4	11.8	L	6116.3	11.6	L		6095.7	11.8	Jo	6125.7	11.7	Pt
	6090.3	11.8	L	6117.3	11.5	L		6096.4	11.8	Ah	6126.4	11.6	Lj
	6091.7	11.5	Br	6118.6	11.5	L		6096.6	11.3	L	6126.5	11.5	Lj
094512 X LEONIS—								6097.5	11.7	Lj	6126.9	11.5	Br
	6068.4	14.7	L	6089.4	12.0	L		6098.9	11.0	Ma	6127.4	11.8	Ah
	6069.4	14.2	L	6090.4	11.9	L		6099.4	11.8	Ah	6127.4	11.3	Be
	6072.3	14.2	L	6091.3	12.0	L		6099.6	11.2	L	6127.5	11.5	Lj
	6073.3	14.5	L	6091.7	13.2	Br		6099.7	11.6	Fd	6127.6	11.6	Lj
	6077.3	12.3	L	6092.3	12.4	L		6099.9	11.4	Pt	6127.6	11.7	Fd
	6078.3	12.3	L	6093.4	12.5	L		6100.5	11.8	Ah	6127.7	11.7	Pt
	6079.3	13.8	L	6096.3	13.8	L		6100.6	11.2	L	6127.7	11.1	Ma
	6080.7	13.0	Br	6097.4	15.0	L		6100.7	11.7	Fd	6128.4	11.6	Lj
	6081.4	14.2	L	6106.3	12.3	L		6100.8	11.0	Ma	6128.5	11.8	Ah
	6083.3	14.7	L	6109.3	13.8	L		6100.9	11.5	Pt	6128.8	11.6	Pt
	6084.7	14.2	Br	6110.3	12.3	L		6101.6	11.2	L	6128.8	11.1	Ma
	6085.3	14.2	L	6112.3	12.8	L		6102.6	11.5	Lj	6129.6	12.0	Jo
	6086.7	13.3	Br	6114.3	12.9	L		6102.9	11.6	Pt	6129.8	11.7	Pt
	6088.4	12.0	L	6116.3	14.2	L		6103.6	11.2	L	6130.6	12.0	Jo
202946 SZ CYGNI—								6104.9	11.6	Pt	6130.8	11.1	Ma
	6086.9	9.0	Pt	6099.9	9.0	Pt		6105.9	11.6	Pt	6130.9	11.7	Pt
	6089.7	9.5	Pt	6100.9	9.0	Pt		6107.1	10.5	Lg	6132.7	11.7	Pt
	6091.7	9.6	Pt	6101.9	9.2	Pt		6113.4	11.6	Lj	6132.8	11.0	Ma
	6093.9	9.2	Pt	6102.9	9.1	Pt		6113.4	11.8	Ah	6138.7	8.4	Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1930.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—					213843 SS CYGNI—				
	6138.8	8.6 Ma	6141.6	8.5 Ma		6143.8	8.6 Ma	6147.6	8.6 Ku
	6139.9	8.3 Ma	6142.8	8.3 Ma					

SUMMARY OF OBSERVATIONS FOR MAY AND JUNE, 1930.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	25	269	Jones	Jo	56	262
Allen, P. R.	Al	3	5	Kohl	Kl	2	3
Baldwin	Bl	69	236	Kusel	Ku	3	3
Beloit College	BE	7	12	Lacchini	L	175	588
Benini	Be	3	6	Leiner	Lj	14	128
Bigelow	Bw	20	38	Leslie	Ll	2	2
Boutell	BL	16	162	Logan	Lg	9	9
Bouton	B	86	113	Marsh	Ma	36	105
Brocchi	Br	43	75	McLeod	Mc	4	4
Brown, A. N.	Bn	4	8	Millard	Md	10	22
Buckstaff	Bc	8	14	Monnig	Mg	4	4
Chandra	Ch	100	148	Nizamiah Obs.	Nz	30	46
Dartayet	Dr	57	124	Peltier	Pt	183	520
Ensor	En	70	184	Smith, F. W.	Sf	19	84
Ford	Fd	37	176	Smith, W. H.	Sm	45	78
Gaebler	Gb	6	10	Swanson	Sw	12	12
Gregory	Gy	10	18	Taffara	Tf	5	10
Haas	HS	17	57	Webb	Wd	16	78
Houghton	Ht	77	305				
				Totals		37	397	3918

Papers read were of timely interest and lead us to hope that at future meetings still more members may be induced to present papers and take active part in their discussion. At the dinner held on Saturday evening, we heard much about Maria Mitchell, both from members of the Association and from Nantuckians. In fact, the toastmaster had little to do or say, once anecdotes and reminiscences connected with Professor Mitchell began to run rampant.

Mr. N. W. McLeod of Christine, North Dakota, submits his first contribution of variable star observations to this report.

RY Sagittarii has undergone a remarkable change in magnitude during the past few months. It needs to be kept under close observation. R Cor. Bor.—the prototype of this class of variable—has been so uniformly bright for so many years past, that it behooves us to be on our guard so that it will not get a start on us, once it begins to decrease in light. A drop in magnitude may occur at any time in the near future.

LEON CAMPBELL, Recording Secretary.

July 9, 1930.

NOTES FROM AMATEURS

Explaining the Distances of the Planets with a Triangle.

Many minds have vainly sought the law governing the distances of the planets from the sun. Approaching the problem from a new angle, on the theory that Nature always chooses the best after many tests, I invite you to join with me in an endeavor to find the best plan for a solar system to be established in an unoccupied portion of space; if successful, we may then determine whether in

our own solar system Nature followed the prize-winning law. Our first task, therefore, is to search for a superior law on which to found a solar system not yet created.

Two dimensions may be represented on a plane surface by two perpendicular lines (Fig. 1) or by two sides of a square (Fig. 2). A third dimension may, with due regard for perspective, be represented on the same plane surface by drawing a third line (Fig. 3) or by the third edge of a cube (Fig. 4); which line or edge,

FIG. 1

FIG. 2

FIG. 7

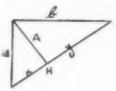


FIG. 8

FIG. 3

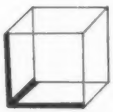


FIG. 4

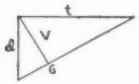


FIG. 9

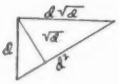


FIG. 10

FIG. 5

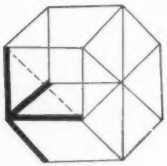


FIG. 6

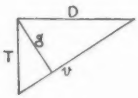


FIG. 11

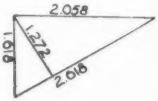


FIG. 12

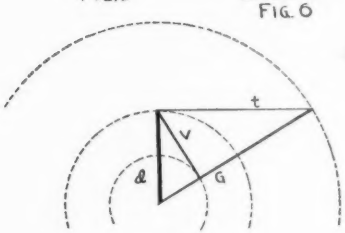


FIG. 13

FIG. 14

though in reality at right angles to the two others, forms an acute angle with the vertical when the figure is drawn on a plane surface; because, to render it visible, the plane containing it has to be shifted, say, to the right and up. It is therefore natural to imagine that a fourth dimension would be susceptible of indication on the same plane surface by completing the star with a fourth line perpendicular to the third (Fig. 5) or by the fourth edge of a fourth-power figure, perhaps appearing as an octahedron (Fig. 6); which line or edge, though in reality at right angles to the three others, forms an acute angle with the horizontal when the

figure is drawn on a plane surface; because, to render it visible, the plane containing it has to be shifted, say, to the right and down. What I seek to convey is not that this drawing pictures a four-dimensional figure, but that if such a figure could be projected upon a plane surface the four directions might be indicated by the rays of an eight-pointed star.

It is apparent from these figures that in a right triangle (Fig. 7) the two legs and the altitude represent three of these directions, and it is therefore reasonable to suspect that the fourth might be susceptible of indication by the right triangle's fourth coördinate, the hypotenuse. You will see that the hypotenuse is parallel to the fourth heavy line and is consequently the same direction.

It should further be observed that whether the two legs of a right triangle be equal as in the preceding figures, or unequal as we shall now consider them, the product of the two legs equals the product of the altitude (A) and hypotenuse (H). Designating (Fig. 8) the longer leg, or base, by b and the shorter side by s, we have the proportion $A:s=b:H$, or $sb=AH$, or $sb/AH=1$, or $1/A\times s\times b\times 1/H=1$; from which value we may hazard a guess that while a right triangle probably represents the four coördinates of a four-dimensional figure, the altitude and hypotenuse represent their dimensions *inversely* (that is, A and H are the reciprocals of the actual dimensions).

An examination of the solar system reveals this same proportion. We know from Kepler's third law that each planet pursues its course around the sun in such a manner that there is a definite relationship of the speed of travel, distance traveled, and time spent in making one revolution, in that the velocity (v) decreases as the square root of the planet's distance (d) from the sun, when the distance is expressed in terms of another planet's distance as unity, and the square of the time (t) increases as the cube of this distance. Since v varies as $1/\sqrt{d}$, the inverse velocity V varies as $\sqrt{d}$, and since t^2 varies as d^3, t varies as $d\sqrt{d}$. For instance, if Mars were four times as far from the sun as Mercury is, its velocity reciprocal V would be twice that of Mercury, its d four times Mercury's distance, its t eight times Mercury's time. We may place the variations in a series $\sqrt{d}$, d, $d\sqrt{d}$, the distance variation being the square and the time variation the cube of the inverse velocity variation, and the ratio is $\sqrt{d}$. But is there not a d^2, a fourth term of the series, a fourth power of the inverse velocity variation, a fourth coördinate of the solar system? There is. It is gravity, which decreases as the square of the distance, so that the inverse gravity G varies as d^2. The variation series is therefore $1/v$, d, t, $1/g$, or $V:d=t:G$, and $dt/VG=1$, or $1/V\times d\times t\times 1/G=1$, *as in the right triangle*, V and G being the reciprocals of the actual variations v and g. This value 1 may mean that the planetary revolution in the solar system is complete with the four coördinates of motion, separation, duration, and attraction, not excluding the possibility, however, of another set. This relationship is so simple and elegant that we may reserve the right to adopt it for our new system. The question then arises: can the planets be arranged at such distances as to form for each coördinate a series that will harmonize with the relationship just discussed? And the answer is, yes.

Observing the similarity between the coördinates of the solar system and those of the right triangle, we are led to suspect that any right triangle might represent in the relations of its coördinates a possible planetary system, and that a right triangle should be discoverable which represents the four variation

values in the solar system (Fig. 9) or with the values indicated in terms of distance as in Fig. 10; that is, a quantity for d where the successive coördinates

form a geometrical power series with the ratio $\sqrt{d}$ and, necessarily by the Pythagorean theorem, $t^2 + d^2 = G^2$, or $d^2 + d^2 = d^4$. Of the infinitude of right triangles one, and only one, fulfills the conditions, being that one whose altitude is the reciprocal or inverse of the square root of the greater segment resulting from the division of unity in extreme and mean ratio, or 1.272 . . . . (There is of course a converse right triangle as shown in Fig. 11, v being ,0.786 . . . . the reciprocal of 1.272 . . .; its series is, descending, v, D, T, g, distance and time being inverse; but the result being the same, the first triangle alone will receive our attention.) The values of the coördinates are shown (to three decimal places) in Fig. 12, and I shall name it the *ratio triangle* on the assumption that it might represent the ratios for the construction of a table of successive planetary distances, times, etc.

Our next step is to construct such a table, using the ratios of the ratio triangle for the respective columns.

TABLE A.

Sun	V	$V^2 = d$	$V^3 = t$	$V^4 = G$
Mercury	1.000	1.000	1.000	1.000
Venus	1.272	1.618	2.058	2.618
Earth	1.618	2.618	4.236	6.854
Mars	2.058	4.236	8.718	17.944
Planetoids	2.618	6.854	17.944	46.978
Jupiter	3.330	11.090	36.930	122.990
(Hespa)	4.236	17.944	76.012	
Saturn	5.388	29.034	156.438	etc.
Uranus	6.854	46.978		
Neptune	8.718	76.012	etc.	
(Planet O)	11.090	122.990		

I now suggest that in the unique ratio triangle we have for our proposed system a basic law unsurpassable in simplicity, beauty, and efficiency, and that we are justified in adopting it, placing our planets at the distances indicated, as I have done in the table, borrowing the names of the members of the sun's family. Each distance is a square of the corresponding inverse velocity, and the sum of any two consecutive squares in the distance column is the next following square. Consequently the three corresponding consecutive Vs must form three sides of a right triangle. But the term preceding the three is always the altitude of that triangle and its square is the *difference* of the squares whose *sum* is the square of the hypotenuse. Hence any four consecutive V terms form the four coördinates of a right triangle. I have therefore named this series the *triangle series*.

Did wise old Nature in the course of ages test out this harmonious law and put it to use? Is it possible that our own solar system is founded on Table A? Kepler and Newton showed the table to be true horizontally; is it, or was it originally, true vertically? Let us see whether there is any agreement of the lawful velocities and distances with what we find in the solar system. We know that the planetary distances are not constant, because, for example, Jupiter has been receding from the sun and Saturn approaching it for a long period, and we cannot be sure that any planet is now at its lawful distance; but surmising that the deviation has not grown so great as to prevent a rough concordance, let us accept the actual distance of Mercury (the nearest planet to the sun) as 36 mil-

lion miles and its time of revolution as 88 days, as computed by astronomers, thus making its velocity 29.75 miles per second. (The average distance of the planetoids is taken as 2.65 astronomical units, the usual calculation.)

TABLE B.

	Lawful Velocity	Actual Velocity	Lawful Distance	Actual Distance
	miles per second		in million miles	
Sun				
Mercury	29.75	29.75	36.	36.
Venus	23.38	21.72	58.25	67.2
Earth	18.39	18.51	94.25	93.
Mars	14.46	14.96	152.5	141.5
Planetoids	11.36	11.36	246.75	246.8
Jupiter	8.92	8.11	399.25	483.
(Hespa)	7.03	.....	646.	...
Saturn	5.54	5.98	1045.25	886.2
Uranus	4.33	4.23	1691.25	1782.2
Neptune	3.38	3.37	2736.5	2791.5
(Planet *O*)	2.70	....	4427.75	.....

The column headed "lawful distance" shows where the planets would be with respect to the sun if they were arranged in the series just described; the last column shows where they now are.

We find (1) a rough agreement for all the planets; (2) the series does not fall down at Neptune, as Bode's law did; (3) it is an actual geometrical law of the highest class, while Bode's was artificial and arbitrary; (4) the hypothetical trans-Neptunian planet *O* is exactly where Flammarion estimated it should be (47.6 astronomical units), using as his basis of calculation the aphelion distance of the orbits of the two comets it has apparently captured; (5) between Jupiter and Saturn a planet is missing, which for convenience I call Hespa, and which is probably there in the form of a farspread shoal of planetoids; (6) the widest divergence is shown by Jupiter and Saturn and is explainable by the Great Inequality, pointed out by Proctor, that through mutual attraction Jupiter has been drawn far outward and Saturn far inward. The validity of the law seems to depend on the presence of planetary matter between these two giant planets at an average distance of about 646 million miles from the sun; and it is easy to believe that, if after the severe exertion of throwing off the great ring forming mighty Jupiter the shrinking nebula was able next to emit only a weak ring which broke up into planetoids, it should be equally natural that after the previous effort of ejecting the great Saturn a weaker ring should follow. Or if the potent influence of Jupiter extending inward restrained the planetoids from aggregating into a single planet, it is reasonable to suppose that the same potent influence would act outward to prevent aggregation, with Saturn lending a helping hand. And it happens that at least one planetoid, Hector, has already been discovered with an orbit beyond Jupiter's.

If you ask what a right triangle has to do with the orbital revolution of the planets, please note that when any lawful orbit (Fig. 13) is taken as a basis, and its radius, or distance, or side of the right triangle, is given the value 1.618 . . ., a tangent from the planet to the next *exterior* orbit will be the longer leg of the triangle and will equal the time 2.058 and would sweep out an area of $\pi(2.058)^2$, the space between the two orbits, which equals the area of a circle with the time t as radius. The tangent from the planet to the next *interior* orbit will be the altitude of the triangle and will equal the inverse velocity 1.272

and would sweep out an area of $\pi(1.272)^2$, the space between the two orbits, which equals the area of a circle with the inverse velocity V as radius. The hypotenuse of the triangle will be the inverse gravity 2.618, as well as the distance of the next planet outward. (The shorter segment of the hypotenuse will be the unit distance 1, that of the next planet inward.) In other words, during a revolution each of the four coördinates sweeps out an area equal to that of a circle with the coördinate as radius.

"Soft upon Chaos He laid His hand
And fashioned a cosmic fairyland
To move to a music that men call laws—"

If Nature adopted this series as the scale for the song of the spheres, we should expect it to be the most remarkable series known to mathematics; and so it is. It results from the division of unity in extreme and mean ratio, the celebrated "golden section," classed by Kepler with the Pythagorean theorem as the two great treasures of mathematics. The greater segment (which is the descending ratio of the distance series) is 0.6180339 . . ., and has these characteristics: when you add it to one you divide one by it; when you subtract it from one you square it; and when you add its square to its cube you get it. It is the side of a regular decagon inscribed in a circle whose radius is unity. It is the unit continuing fraction (Fig. 14). The distance series is not only a geometrical power series, but also the only power series that is likewise an additive series, *i. e.*, where each term is the sum of the two preceding terms. The ascending ratio, 1.618033988749978 . . ., is the base of every additive series; for, if you take any two numbers whatever and add them to get a third number, then add the second and third to get a fourth, the third and fourth to get a fifth, and so on, the quotient derived from division of the last number by the one preceding will soon be 1.618+ and will approach nearer and nearer to the incommensurable ratio 1.61803398749978 . . . as the addition continues. For several unusual features of this series the reader is referred to an article by Wm. Schooling in the appendix of Theodore A. Cook's book, "The Curves of Life", where I found them mentioned at a publication date that is prior to my first discovery of them. I have already shown, too, that in our ratio triangle not only is it true, as of all right triangles, that the square on the hypotenuse equals the *sum* of the squares on the sides, but it is also true, as of no other right triangle except in the triangle series, that the square on the altitude equals the *difference* of the squares on the sides.

We may like the law still better when, observing a cycloid closely and knowing it could represent a sun in translation with a circling planet in the same plane, we find that if the sun's velocity be taken as 1, the velocity of the planet will be 1.273, almost exactly the value of the inverse velocity in our triangle, 1.272. 1.273 is also the ratio of a circle's, or ellipse's, area to the square, or rectangle, in which it is inscribed. Moreover, from the book cited above and other sources, we learn of the prevalence of the additive series in Greek art (Hambidge), in shell growth, in the distribution of plant leaves (Fibonacci series), in the proportions of the human body; we find it too in a spider's web, in the lunations of the moon, and now in planetary relations.

To summarize what I have tried to show: if there is a law governing the present or former distances of the planets from the sun, it is probably the law of the "golden section"; the right triangle seems to represent four coördinates of a system, two direct and two inverse; the only possible right triangle with

its four coördinates representing four consecutive powers is the triangle whose coördinates are the velocity, distance, time, and gravity ratios of our solar system; and finally, allowing for the disturbing influences—interplanetary attraction and what not—prevailing over an incalculable time, the planets still wander around the sun at distances roughly approximating the plan which accounts for them all. If Leverrier and Adams had based their computations on this law, their labors to locate Neptune would have been greatly simplified; and if Prof. W. H. Pickering will do so in his efforts to locate the trans-Neptunian planet, perhaps he will shorten his way to success.

NOTE.—The typing of this manuscript was completed on March 13, 1930, and in that afternoon's newspapers announcement was made from the Flagstaff Observatory that the long-sought trans-Neptunian planet had been discovered at a distance of approximately four billion, two hundred million miles from the sun, a pleasing confirmation of our law which placed it at four billion, four hundred million. In this connection I wish to quote from an interview given by me to the *Tampa (Fla.) Telegraph* and published in its issue of February 7, 1926 (copy of which is in my possession), explaining the series which in the foregoing article has been dealt with from its more technical side. The newspaper said: "Mr. Spahr closed the interview with the *Telegraph* representative by summing up his predictions as follows:

"1) The planet beyond Neptune will be found at about 4400 million miles from the sun. 2) A shoal of planetoids will be found between Jupiter and Saturn at an average distance of about 650 million miles from the sun. 3) If a planet is found between Mercury and the sun, it will be at a mean distance of about 22 million miles and make a revolution in about 42 days, averaging about 38 miles a second."

The first of these predictions came true with the discovery of the new planet by the Flagstaff Observatory. Will astronomers use the law to find the Hespa planetoids and possibly Vulcan, or will they go on spending years in calculations and observations that might to a great extent be omitted? I take no credit for guessing the planet's location correctly, for that had also been done by Camille Flammarion, Prof. Lowell, Prof. Todd, and probably others; but the method employed by me deserves attention, I believe, as a possible means of furnishing additional knowledge of our solar system.

H. L. SPAHR.

319 State Capitol, Atlanta, Ga.

Precession.

Astronomers declare the phenomenon of the precession of the equinoxes to be one of the most interesting in all the known universe, but one of the most difficult to understand and explain. It would seem, therefore, for an amateur of amateurs to profess the one or attempt the other would confirm Pope's line, that

"Fools rush in where angels fear to tread."

Be that as it may, I shall be pleased to have caused one person at least to turn his attention to this wonderful piece of nature's mechanism.

What is it? The sun is said to cross the line (The Equator) twice a year, about the 21st of September and March. At these dates for a moment the sun is vertical over the equator and days and nights are equal all over the earth, "Equinoxes", and at no other time.

Stand on the equator in September where the sun is vertical over the equa-

tor and drive a stake there. Move west 50".2 or about 308 rods and 1 foot and drive a stake there and if you have the time, stay there for one year or until the sun crosses the line again going south, and instead of crossing at the stake for the first crossing it will cross at the second stake. And so each year it crosses 50".2 or about 308 rods and 1 foot west of where it did the year before. By calculation, you will find that it will require about 25,868 years for these crossings to encircle the globe. And this is one phase of the precession of the equinoxes.

Shakespeare causes Caesar to say

> "But I am constant as the northern star,
> Of whose true fixed and resting quality
> There is no fellow in the firmament."

Polaris as one of the millions of stars is just as fixed but not more so than the others, but as the pole star it is not fixed at all. The north pole is pointing to a spot within 1¼ degrees of Polaris and will get within ½ degree of it within a few years and then pass on in its precessional orbit until it is 47 degrees from Polaris, when our friends about 12,000 years hence will probably be pointing to the beautiful Vega as the north star. This brings us to a second phase of the precession of the equinoxes. Get a ball of yarn, say 5 inches in diameter. Run a knitting needle through the center. Start another needle one inch from the first one, run it through the ball crossing the first one at the center of the ball coming out one inch from the first needle on the opposite side from which it started. Stand the first needle on a board representing a plane parallel with the plane of the earth's orbit, perpendicular to it. The second needle is the earth's axis on which it daily revolves. The ends of the axis are the north and south poles of the earth and the spots in the heavens to which the poles point are the celestial north and south poles and the phenomenon described at the north pole is taking place at the south pole at the same time. Now the same force that caused the place of the sun's crossing to move west on the equator 50".2 causes the poles to move in a circle around the perpendicular at the rate of 50".2 each year and hence causes the celestial pole (which as you know is simply an extension of the terrestrial pole) to move in a circle among the stars at the same rate, and as it comes near to some star such star is adopted as the pole star. If there were no other movements among the stars including Polaris it is probable that 26,000 years from now, Polaris would again be the north star. But that is another problem. I have attempted to state what takes place. Why? Astronomers tell us that were the earth a perfect globe, there would be no precession of the equinoxes, no 26,000 year circle performed in the heavens. They say the earth is not a perfect globe, but spheroidal, bulging at the equator. The sun and moon when not directly over the equator pull more strongly on the bulge, causing a gyratory or top motion of the earth, resulting in the remarkable phenomenon of the earth making one revolution in about 25,868 years on the perpendicular axis as represented by the first needle. Sprinkle some flour on the board. Stand the ball with the perpendicular needle, in the center of the flour. Hold it firmly and at the same time press gently on the other needle. Let a second person turn the ball around the perpendicular axis. The needle representing the inclined axis will mark in the flour a circle, which represents one of the two circles made by the north and south poles in the heavens in the precessional period of about 26,000 years.

COMET NOTES

By G. VAN BIESBROECK.

FORBES' COMET 1930 *c*. The fifth cometary discovery of this year came from the southern hemisphere; the four previous ones were by observers on this side of the equator. The new comet was found by A. F. I. Forbes of Rosebank (Capetown), this being the third one picked up by this observer. He informed the Johannesburg Observatory of his finding and the first announcement thus came as an accurate observation by H. E. Wood:

1930 June 2 at $2^h\,55^m.2$ U.T. R.A. $23^h\,33^m\,56^s.1$; Decl. $-32°\,48'\,33''$; Magnitude 9.
Daily motion: $-4^m\,20^s$ and $+24'$.

At that time it was not in reach of northern observers but from the daily motion it was probable that the comet would become visible here too. This was confirmed when the first orbit, computed by H. E. Wood, was telegraphed on June 7:

$$\left.\begin{aligned} T &= 1930\ \text{May}\ 10.588\ \text{U.T.} \\ \omega &= 321°\ 8' \\ \Omega &= 278\ 13 \\ i &= 97\ 15 \end{aligned}\right\} 1930.0$$
$$q = 1.1530\ \text{astr. units}$$

Although these elements depend on a short interval of time, subsequent observations showed that they were close to the truth. The nearest distance from the sun was passed for nearly a month at discovery but the distance from the earth decreased until June 21 so that the object remained fairly well visible in the latter part of June. The brightness was estimated visually as 11^M by the writer on June 21 and on that date there was a broad tail about 3′ long in position angle 210°. The nucleus, however, was not brighter than a star of 13th magnitude. The brightness soon faded with the increase of distance. The following ephemeris computed from Wood's elements shows that the comet is well situated in the constellation of Hercules, but that by August 1 it will be out of reach of all but the most powerful instruments.

1930 0^h U.T.	α h m	δ ° ′	M
July 18	16 30.6	+24 36	14.5
22	20.6	25 15	14.8
26	13.2	25 39	15.1
30	7.8	25 51	15.4
Aug. 3	3.8	25 57	15.6
7	16 1.1	25 58	15.8
11	15 59.4	25 56	16.0
15	58.5	25 51	16.2
19	58.2	25 45	16.4
23	58.5	25 38	16.6
27	15 59.4	25 30	16.7
31	16 0.6	+25 22	16.9

On July 7 the correction of the ephemeris was $+1^m.4$ and $-6'$. The elements of the orbit do not suggest any identity with previously observed comets.

The other comets found in the first part of the year are now either faint or no longer visible:

BEYER'S COMET 1930 *b* has reached the high declination of 57° in the beginning of July and will remain visible in the evening sky for a good number of months to come. The Berkeley computers E. C. Bower and Miss C. E. Moore have made a laborious investigation of the rather discordant observing material up to April 22 from which they conclude that there is no reason so far to adopt an elliptic orbit such as they had deduced (p. 241) from partly erroneous positions. The best parabola comes out as follows:

$$\begin{aligned} T &= 1930\ \text{April}\ 18.2945\ \text{U.T.} \\ \omega &= 24^\circ\ 42'\ 10\overset{''}{.}0 \\ \Omega &= 116\ \ 23\ \ 27.7 \quad 1930.0 \\ i &= 71\ \ 57\ \ 19.3 \\ q &= 2.078071\ \text{astr. units} \end{aligned}$$

leading to the ephemeris

1930	α	δ	
0^h U.T.	h m s	° ′ ″	M
July 7	9 46 19.1	+56 58 26	12.3
15	10 14 32.8	56 55 29	
23	10 43 15.6	56 36 12	
31	11 12 03.4	56 00 43	
Aug. 8	11 40 33.6	55 09 53	
16	12 08 26.1	54 04 50	12.6
24	12 35 26.9	52 47 11	
Sept. 1	13 01 26.7	51 19 09	
9	13 26 18.3	49 43 02	
17	13 50 00.5	48 01 09	
25	14 12 34.6	46 16 01	13.0
Oct. 3	14 34 02.4	+44 30 03	

An independent computation by C. H. and M. H. Smiley led to a slightly elliptic orbit (*Beob. Zirk.*, No. 20); the elements are not published but the ephemeris differs very little from the one above.

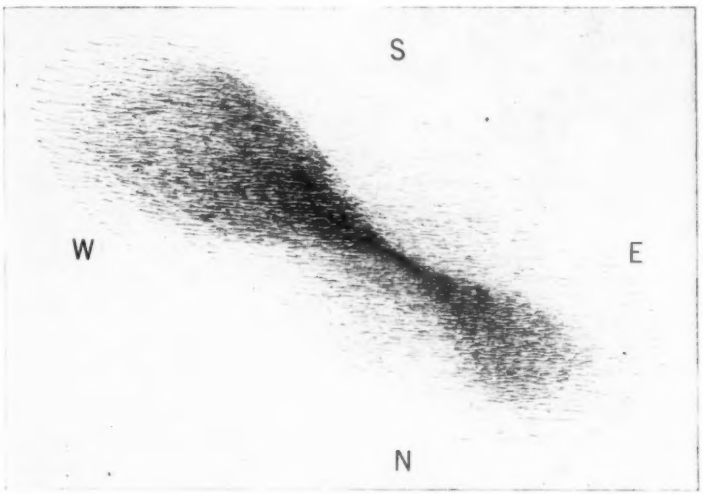
COMET WILK 1930 *c* has been further observed under increasingly difficult conditions. In May it had taken the appearance of a diffuse coma showing hardly a nucleus. In June the comet appeared as a vague nebulosity on which only rough measures could be made; in the first days of July it was at the limit of visual observation with the 40-inch refractor, having dropped to a total brightness corresponding to that of a 15^M star; the apparent diameter was still fairly large, 3′ or 4′, but the absence of condensation made it difficult even to notice the presence of the object in the field of view. Further observations will probably be possible photographically. T. Banachiewicz has made a revision of his orbit (p. 376) with the use of observations on March 22, April 27, and June 16. The change in the elements is immaterial except that the period is reduced from 494 to 466 years. This figure will need further revision when all the observing material is at hand, and it will be interesting to investigate if this bright comet can not be identified in the records of past centuries.

COMET SCHWASSMANN-WACHMANN 1930 *d* is no longer visible in the northern hemisphere and it is questionable if it is still bright enough for southern observers. The illustration on p. 374 shows the appearance of the comet from a plate taken here May 24. But this does not bring out the unusual aspect of the central part of the coma which was over exposed in an effort to record the total extent of the streamers. I have made a pen-drawing in order to give a better idea of how the comet looked in the telescope (May 31). The two tails are clearly pronounced and almost equally bright where they start out from the elongated

nucleus. The first one, in position angle 53°, which is the normal one nearly opposite to the direction of the sun, could be seen over a length of 15′ in the finder; the second, abnormal one, was visible over twice that length in position angle 242°. Both branches start as very narrow streamers at the nucleus and gradually broaden out while losing in brightness. Computations on this comet's orbit have brought out the fact that it clearly describes an elliptic curve, thus adding one more member to the list of short period comets. From observations on May 2, 12, and 22, A. C. D. Crommelin has deduced the following elements:

$$\begin{aligned} T &= 1930\ \text{June}\ 14.1826\ \text{U.T.} \\ \omega &= 192^\circ\ 18'\ 18\overset{''}{.}9 \\ \Omega &= 76\ 47\ 11.5 \\ i &= 17\ 24\ 34.8 \\ e &= 0.673749 \\ q &= 1.011441\ \text{astr. units} \\ a &= 3.10019\ (\text{Period}\ 5.4586\ \text{years}) \end{aligned} \Big\} 1930.0$$

which show that the curve described extends from the earth's orbit to that of Jupiter. The inclination is not large so that in the course of time considerable perturbations may develop through near approaches to the most massive planet of the solar system.



Drawing of Comet Schwassmann-Wachmann on 1930 May 31.

It is an interesting circumstance to note that on June 3, the day when the comet passed from the northern into the southern hemisphere it was independently rediscovered by Blathwayte of Johannesburg, showing that the southern skies are carefully watched by South African observers. The later computation indicates that the comet was then only four million miles away from the earth.

Comet Stearns 1927 IV is still in reach of powerful instruments. With the 24-inch reflector I secured a couple of plates on July 1, on which the comet is again recorded. The small object differs only slightly from the appearance of the

faint stars surrounding it. The magnitude was estimated as 17 and the ephemeris still holds quite closely. At the time the comet was 10.2 astronomical units away from the earth, and 10.0 units from the sun, so that it is now more remote than the planet Saturn (9.6 astr. units) and well on its fourth year of visibility!

Williams Bay, Wisconsin, 1930 July 17.

METEOR NOTES

By CHARLES P. OLIVIER.

The arrival of the spring showers and the possibility of seeing two more in June have been factors in encouraging observations of meteors. We therefore have many records on which to base this article. The outstanding feature is again the splendid set of results from McIntosh on the Eta Aquarids. As the writer had long suspected, it is now proved that these meteors, which are connected with Halley's Comet, give a fine annual shower in the Southern Hemisphere. McIntosh is able to show the daily motion well, a thing that no observer can be expected to be skillful enough to accomplish without some years of practice. In Australia, R. C. Shinkfield, who only began meteor work last year, also got good results during the first four days of the shower. The radiants of both observers appear below.

While the shower predicted as a possibility by Yamamoto did not materialize according to most observers, still certain dates in late May and early June furnished a higher hourly rate than usual. So the earth was surely receiving an extra supply of meteors from somewhere. Nevertheless our member, Paul S. Watson of Baltimore, Maryland, observing with Mr. Frank Oertle and Mr. Joseph Field, on June 10 reported a most unusual display. They saw 51, all radiating within 3° of Gamma Delphini, from 9:15 to 9:45 E.S.T. From that to 11^h, no more appeared. They were all very short, duration also brief; 39 were of magnitude 1, and 10 of magnitude 0. The full moon would have prevented faint meteors from being seen. Their color was yellowish white.

The writer calculated roughly the altitude of Gamma Delphini for that time at Baltimore and found it about 12°. That same night was one of the most transparent we have had at Flower Observatory. Exactly at 9:45 the writer went outdoors and observed most of the time for the next half hour, hoping to see meteors, but none appeared. Dr. S. G. Barton, who was at the 18-inch refractor, at my request went outside and made several 10 to 15 minute watches, one before mine. Neither of us saw a meteor. Despite the moonlight we on that night could easily have seen 3-magnitude meteors. So again we have a case of a brief shower of meteors, seen at one place, but not elsewhere. Obviously Gamma Delphini was nowhere near the position Yamamoto predicted for meteors from Comet 1930 *d*.

Two heights of meteors have been calculated, the one by F. W. Smith from a duplicate observation made by himself at Glenolden and R. W. Wilson, Jr., at Duncannon. The meteor was of magnitude 1-2. The heights were: $h_1 = 182.2 \pm 6.2$ km, $h_2 = 127.8 \pm 6.3$ km. The meteor was at 9:27 E.S.T., June 13, 1930. The other refers to the end point of a bright —1 magnitude meteor observed in Texas on May 21, 1930, at 11:00 C.S.T., by Monnig at Burleson and Milton Mehl at Ft. Worth. The observed part of the path was only about 1°. Therefore only the end point was computed. This came out excessively low, namely 24.7 ± 2.5 km.

The base line, however, was only about 12 miles long. Monnig saw a train for 10 seconds, then with his binoculars followed it, after it had disappeared to the naked eye, for slightly over 2 minutes, during which it broadened slowly and grew fainter. He says: "Long before this time had elapsed . . . attention was caught by a faint ball of hazy light, a short distance out from the forward end of the meteor's path. This distinctly cometary looking object was about 5′ in diameter, and it slowly drifted forward, in a continuation of the meteor's path, traversing altogether perhaps one degree . . . before . . . faded to invisibility." The meteor itself ended in a flash. The height was calculated by the writer.

Between the publication of M4, where the serially numbered radiants ended at No. 1541, and the December, 1929, Meteor Notes, where they were resumed at No. 2000, many radiants were published in previous Meteor Notes. To bring these into conformity, the promise was made that a key would be published. This is now being done for 1929, the first radiant being given the number 1801. Our members are urged to enter these numbers in the proper places in their issues of POPULAR ASTRONOMY or in Reprint No. 5. The notes go by monthly issues.

		Radiants	Numbers
January	Texas Group	4	1801-04
April	McIntosh	9	1805-13
May	McIntosh	5	1814-18
June	Anyzeski	8	1819-26
	McIntosh	5	1827-31
	Darling	9	1832-40
	Anyzeski	7	1841-47
	Olivier	1	1848
August	Texas Group	7	1849-55
	McIntosh	32	1856-87
November	Alden	4	1888-91
	Shinkfield	3	1892-94
	McIntosh	36	1895-1930
	McIntosh	20	1931-50

We welcome the following new members in the order of their joining:

C. L. Higgins, 46 East 26th Street, Baltimore, Maryland.
G. W. Ridley, 425 Haight Avenue, Alameda, California.
L. W. Smith, Whitemans Valley Rd., Silverstream, Herataunga, Wellington, New Zealand.
Milton Mehl, 1215 Main Street, Fort Worth, Texas.
E. H. Hardy, Swakino Road, Takuiti, Auckland, New Zealand.
Chester Davis, Camp Echo, Long Lake, Fremont, Michigan.
N. W. Hopkins, 8001 Ft. Hamilton, Parkway, Brooklyn, N. Y.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1930 July 26.

R. A. MCINTOSH, AUCKLAND, NEW ZEALAND.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate
April	29	15:00	17:00	120	27	1.0	13.5	13.5
May	2	14:56	17:20	144	37	0.9	15.4	17.1
	4	14:45	17:25	160	72	1.0	27.0	27.0
	5	14:45	17:25	160	65	1.0	24.3	24.3
	6	14:30	17:30	180	84	1.0	28.0	28.0
	7	14:30	17:30	165	63	0.9	22.9	25.4
	8	14:40	16:25	105	39	1.0	22.3	22.3

R. C. Shinkfield, Adelaide, South Australia.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
April	28	16:45	17:45	60	14	1.0	14.0	14.0	No Aquarids
May	1	16:20	17:50	90	21	1.0	14.0	14.0	8 Aquarids
	2	15:45	17:45	120	27	1.0	13.5	13.5	12 Aquarids
	3	16:35	17:55	80	22	1.0	16.5	16.5	11 Aquarids

V. Anyzeski, New Haven, Connecticut.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate
Feb.	28	6:45	8:00	75	12	1.0	9.6	9.6
April	14	8:00	9:00	60	6	0.6	6.0	10.0
	19	9:15	11:15	120	11	0.7	5.5	7.9
	20	7:50	11:00	190	23	0.9	7.3	8.1
May	31	10:15	11:34	79	14	0.8	10.6	13.2
June	1	11:00	12:00	60	14	0.8	14.0	17.5
	3	10:45	11:50	65	15	0.6	13.9	23.2
	12	10:00	11:15	75	12	0.9	9.6	10.7

Gordon W. Ridley, Alameda, California.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
March	20	12:15	13:30	75	1	0.9	0.8	0.9	
April	3	13:10	14:13	63	7	0.9	6.7	7.4	1 earlier
	16	12:48	13:20	32	2	0.4	3.8	[9.5]	Moon & clouds
	19	11:08	12:32	84	4	0.7	2.9	4.1	
	21	12:17	14:45	43	9	0.6	12.5	20.8	
	22	12:15	13:48	62	8	0.7	7.8	11.1	
May	21	12:17	14:01	59	8	1.0	8.2	8.2	
	22	13:00	13:45	45	2	0.9	1.5	1.7	
	29	12:15	12:35	20	2	0.9	6.0	6.7	
	30	11:45	13:00	75	3	0.9	2.4	2.7	

MICHIGAN GROUP.

B. C. Darling, Lansing, Michigan.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
May	20	9:35	10:05	30	2	0.8	4.0	5.0	
	21	9:30	10:05	35	2	0.9	3.4	3.8	
	22	9:26	10:25	59	1	0.9	1.0	1.1	
	24	12:05	13:45	100	9	1.0	5.4	5.4	
	28	9:45	10:15	30	0	0.8	0.0	0.0	
	29	10:16	13:25	155	13	0.8	5.0	6.3	
	30	9:40	13:57	170	14	0.9	4.9	5.4	
	31	13:50	15:00	70	9	1.0	7.7	7.7	
June	3	9:47	10:45	58	1	0.6	1.0	1.7	
	4	9:55	10:35	40	2	0.9	3.0	3.3	
	8	9:39	10:29	50	0	0.5	0.0	0.0	
	9	11:25	12:25	60	2	0.4	2.0	[5.0]	
	12	10:00	11:42	..	3	0.8			irregular watch
	13	9:35	14:10	195	7	0.9	2.2	2.4	
	14				8				casuals
	16	10:00	11:07	67	13	0.9			by 4 observers
	19	9:35	11:35	120	8	1.0	4.0	4.0	5 casuals later
	20	11:15	12:30	75	11	0.9	8.8	9.8	
	21	12:09	14:10	121	10	0.8	5.0	6.2	
	25	9:45	10:20	35	2	0.9	3.4	3.8	
	27	9:35	10:35	60	2	0.9	2.0	2.2	
	28	12:39	14:09	90	12	1.0	8.0	8.0	

H. W. Cantrell, Lansing, Michigan.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
June	19	9:35	11:35	120	12	1.0	6.0	6.0	count only
	20	9:45	12:30	165	21	0.9	7.6	8.4	count only
	21	10:00	11:30	90	18	0.8	12.0	15.0	count only

TEXAS GROUP.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
May 21	10:05	11:02	53	7	1.0	8.0	8.0	(1)
24	9:33	11:40	85	13	1.0	9.2	9.2	(2)
30	9:05	11:05	120	12	0.8	6.0	7.5	by O. E. Monnig
31	9:25	11:42	137	16	1.0	7.0	7.0	(3)
June 8	9:35	10:35	60	3	0.4	3.0	[7.5]	by O. E. Monnig
16	9:00	10:45	105	5	0.8	2.9	3.6	by O. E. Monnig
16	9:00	10:45	105	3	0.8	1.7	2.1	by A. Burns
25	10:30	11:45	75	3	0.7	2.4	3.4	by A. Burns
25	10:30	11:45	75	5	0.7	4.0	5.7	by M. Mehl

(1) By O. E. Monnig and S. Bunch alternating. (2) By O. E. Monnig; four more by R. Brown; (3) By O. E. Monnig; five by R. Brown.

DAN F. WAUGH, TOKYO, JAPAN.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
June 29	13:00	14:40	100	7	1.0	4.2	4.2

H. A. BURNS, SPRING VALLEY, NEW YORK.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
June 25	9:03	10:45	102	6	1.0	3.5	3.5
27	12:26	14:30	124	7	1.0	3.4	3.4
28	9:00	10:45	105	10	1.0	5.7	5.7
28	12:14	14:10	116	20	1.0	10.4	10.4

FRANKLIN W. SMITH, GLENOLDEN, PENNSYLVANIA.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
May 30	9:00	10:05	65	2	1.0	1.9	1.9
June 15	8:43	9:43	60	2	1.0	2.0	2.0
21	8:45	10:05	80	2	1.0	1.5	1.5
July 4	10:00	10:40	40	1	0.6	1.5	2.5

C. P. OLIVIER, FLOWER OBSERVATORY, PENNSYLVANIA.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
June 26			30	5				casuals; after 13[h]

RADIANTS BY R. A. MCINTOSH.

A.M.S. No.	1930	α	δ	Meteors	Wt.	Remarks*
	April					
2144	29.69	251°.0	—28°.7	5	Good	
2145	29.69	270.0	—10.0	4–5	Fair	
2146	29.69	321.	—19.	3	Fair	See 2153, 2163, 2170; (147, 148).
2147	29.69	330.3	— 3.5	5	Fair	Eta Aquarids.
	May					
2148	2.69	270.5	—27.0	2	Fair	See 2151, 2157, 2160, 2167; (149, 160, 167, 171).
2149	2.69	286.0	—37.0	3	Fair	
2150	2.69	334.0	— 2.0	19	V. Good	Eta Aquarids
2151	4.69	271.0	—29.0	3	Fair	See 2148, 2157, 2160, 2167.
2152	4.69	302.3	—21.5	6	Good	See Mc92, Mc94; (156, 161, 173).
2153	4.69	322.0	—16.0	3	Fair	See 2146, 2163, 2170.
2154	4.69	324.0	— 4.5	6–7	Good	One stationary meteor. See 2164, 2171, 2175.
2155	4.69	326.0	—35.0	3	Fair	One meteor May 2. See 2158, 2162; (151, 164).
2156	4.69	336.5	— 1.5	35–36	V. Good	Eta Aquarids
2157	5.69	277.0	—27.0	3	Fair	See 2148, 2151, 2160, 2167; (149, 160, 167, 171).
2158	5.69	327.0	—33.0	2–3	Poor	See 2155, 2162; (151, 164).
2159	5.69	337.0	— 1.0	32–33	V. Good	Eta Aquarids
2160	6.69	272.0	—27.0	5	Good	See 2148, 2151, 2158, 2167; (149, 160, 167, 171).

A.M.S. No.	1930 May	α	δ	Meteors	Wt.	Remarks
2161	6.69	305°.0	+17°.0	3	Fair	See 2169, 2174; (157, 162, 174).
2162	6.69	325.5	—34.5	4–5	Good	See 2155, 2158; (151, 164).
2163	6.69	326.0	—16.5	3	Fair	See 2146, 2153, 2170; (150, 147).
2164	6.69	327.0	— 2.5	8–9	Good	See 2154, 2171, 2175; (35).
2165	6.69	338.0	— 0.5	36–38	V. Good	Eta Aquarids
2166	6.69	356.0	— 5.0	4	Good	One meteor May 5.
2167	7.68	270.0	—30.0	3	Poor	See 2148, 2159, 2160, 2151; (149, 160, 167, 171).
2168	7.68	298.5	— 1.2	4	Fair	One meteor May 8.
2169	7.68	308.0	+15.0	5	Good	See 2161, 2174; (157, 162, 174).
2170	7.68	324.5	—15.0	3	Fair	One meteor May 8; See 2146, 2153, 2163; (147, 150).
2171	7.68	329.0	— 1.0	5–7	Good	See 2154, 2164, 2175.
2172	7.68	339.0	0.0	28	V. Good	Eta Aquarids.
2173	7.68	351.0	—46.0	3	Fair	One meteor May 6.
2174	8.67	307.5	+14.5	3	Good	See 2161, 2169; (157, 162, 174).
2175	8.67	330.0	— 1.0	3	Good	See 2154, 2164, 2175; (35).
2176	8.67	336.5	— 0.5	3–4	Good	
2177	8.67	338.0	—30.5	5	Good	
2178	8.67	340.0	+ 0.5	12–13	V. Good	Eta Aquarids
2179	7–8c	310.5	—49.3	5	Good	(158, 163).

UNCERTAIN RADIANTS.

No.	1930 May	α	δ	Meteors	Wt.	Remarks
Mc91	2.69	275°	+28°.5	2	?	
Mc92	2.69	299	—21.5	2	?	See 2152, Mc94.
Mc93	5.69	282	+12.	2	?	
Mc94	5.69	300	—21.	2	?	See 2152, Mc92.

RADIANTS BY R. C. SHINKFIELD.

A.M.S. No.	1930 May	α	δ	Meteors	Wt.	Remarks
2180	1	307°.5	—30°.	3	Poor	
2181	1	336.5	— 1.7	8	Good	Eta Aquarids
2182	2	303.	—11.	3	Good	4-5 more meteors May 1 and 3.
2183	2	335.0	— 4.4	12	Good	Eta Aquarids.
2184	3	336.4	— 0.4	11	Good	Eta Aquarids.

*The bracketed numbers refer to those as published in Meteor Notes during 1929, which were given by McIntosh himself.

The Supposed Bezerros Meteorite.

In preparing the article on the Paragould meteor and meteorites, the writer made the statement that the big Paragould meteorite is the largest for which the date of fall is known. This was written in spite of the fact that the most recent catalogues of meteorites list a 20-ton iron as falling near Bezerros, Brazil, on May 9, 1915. Like Dr. Farrington of the Field Museum, Dr. Fisher of Harvard, and Dr. Spencer of the British Museum, we questioned the authenticity of the report. It was, however, thought best to reivse the article to include the Bezerros supposed fall, and investigate the authenticity for a separate note.

This reported fall entered catalogues of meteorites through its inclusion in a list of meteoric falls prepared by H. Michel. The listing, from *Fortschritte der Mineralogie, Kristallographie und Petrographie*, Volume VII, page 258, is: "Bezerros (592), Munizip Bezerros im Staate Pernambucco, Brasilien. Eisen, Am 9. Mai 1915 niedergegangen, wird auf 20 Tonnen geschätzt."

Turning to (592) for the authority one finds: "592. Noch ein grosseres

Meteor im Brasilien. Prometheus 1915, 26. Bd., Beibl., S. 184."

This reference, from the August 14, 1915, issue, N. 1346, is as follows: "*Noch ein grosseres Meteor im Brasilien* (s. *Prometheus* Nr. 1321, Beibl.). Im Munizip Bezerros, Staat Pernambucco, ist nach einer Notiz in der Deutschen Zeitung von Porto Alegre vom 9. April 1915 ein ungeheures Meteor niedergegangen, dessen Gewicht auf 20 Tonnen (20,000 kg) geschätzt wird. Sonach dürfte es den grossen Meteorolithen von Bendego, Staat Bahia, im Landesmuseum zu Rio, der vor etwa 30-40 Jahren gefunden wurde, noch übertreffen."

The reference to Beiblatt Number 1321, which dated 20. II. 1915, is as follows: "*Ein gewaltiger Meteorolith,* der grosste, den man bisher auf unserem Planeten gefunden hat, fiel nach einer Notiz der *Deutschen Zeitung von Porto Alegre* vom 21. 8. 14 an den Quellen des Rio Piracahuba im Munizip S. Sebastião da Boa Vista. Er verursachte bei seinem Fall ein formliches Erdbeben und setzte den umliegenden Wald in Flammen. Der Donner des Falles wurde noch in den Stadten Curralinho und Cametá (am Tocantinsflusse) vernommen."

The last note is the earliest, and reports a brilliant detonating meteor which presumably fell in Para, northern Brazil. We are told that it attracted attention in Sao Sebastião da Boa Vista, Curralinho, and Cametá. This suggests an important meteor, but not necessarily that meteorites of any size reached the surface of the earth. Probably none were recovered. The account is taken from the August 21, 1914, issue of a German language newspaper published in Porto Alegre, Rio Grande do Sul, southern Brazil, thousands of miles from the supposed fall.

The second note informs us that the April 9, 1915, issue of this same newspaper announces that an immense meteor of estimated weight 20 tons had fallen near Bezerros in Pernambucco. Details are lacking. Date of fall is not given. There is no statement that the meteorite has been found, and no description. One suspects that a Bezerros newspaper had reprinted an account of the Para meteor, described in the earlier note, without a definite statement that it had been observed quite far from Bezerros. A second possibility is that another bright meteor was actually seen by residents of Bezerros or some neighboring community. The 20-ton estimate is no evidence that any meteorites actually reached the surface of the earth. A third possibility is that some one found a big rock near Bezerros, which for some reason he thought might be meteoric, and that eventually this report reached the Porto Alegre newspapers

The first note quoted, the listing of Michel, appears to be taken rather carelessly from the later *Prometheus* note. The date of issue of the Porto Alegre newspaper, April 9, 1915, was copied May 9, 1915, and what was worse, this date was put down as the date of fall of the meteorite. Also, the supposed meteorite was listed as iron, although the reference gave no such information.

To summarize—It is certain that the report of this big iron did not start with a meteoric fall near Bezerros on May 9, 1915. It probably started with a typical newspaper story on a brilliant meteor, or a big rock thought by some one to be meteoric. Eventually, and presumably with some modifications, this story reached a German language newspaper in southern Brazil, from which it went to *Prometheus*, and from *Prometheus* to Michel's listing. We find that the date of fall, and the description "iron," were added in the last copying.

Some readers may believe that we have been too skeptical in passing on these notes, so in conclusion we offer two newspaper clippings reporting bigger meteoric falls than the Bezerros. The first is from a midwestern newspaper of date July 31, 1929, as follows: "Astronomers at the University of ——— believe that ———

the largest part of the mass fell in Lake Michigan. Some scientists estimate that the projectile weighed thousands of tons, and would have caused considerable loss of life if it had struck in a densely populated city like Chicago." This clipping refers to the brilliant meteor of July 25, 1929. The opinion attributed to astronomers and scientists is not essentially different from that held by some educated persons; but it is quite different from that of a person familiar with meteors. The map in POPULAR ASTRONOMY, **37**, 515, 1929, shows that if any meteorites reached the surface of the earth they fell quite far from Lake Michigan. Instead of an estimated weight of "thousands of tons," one finds in the same volume on page 516 the opinion ventured that "no stones larger than ten or fifteen pounds reached the surface of the earth, and as several square miles of territory must be searched their recovery will be improbable" As a matter of fact, no meteorites have been recovered.

As another clipping announcing an immense meteorite, we offer the following: "Managua, Nicaragua, Feb. 25.—An immense meteor, said to be 600 feet long by 50 feet wide, which fell from the heavens diagonally across the city of Leon last Sunday, has been found on a beach on the Pacific, between Leon and Corinto. The meteor was visible from Managua, fifty miles from where it fell. It had the appearance of a gigantic, blazing sky-rocket, followed by a long streamer of sparks. Great excitement was caused in a movie theatre in Leon, as the meteor appeared to be falling into the city." This report, like the Bezerros, does not mention detonations, which are practically always included in items reporting authentic falls. A meteorite 600 feet long by 50 feet wide should have produced another Meteor Crater where it struck, and there is no indication of such a thing in this report, which, as far as we know has attracted no interest in scientific circles.

C. C. WYLIE.

University of Iowa, July 19, 1930.

Note on the Possibility of Hearing "Meteor Static".

The idea that meteors produce electrical disturbances in the atmosphere has already been advanced by some writers. E. H. Sellards in his paper, "The Texas Meteor of June 23, 1928," *University of Texas Bulletin* 2901, October, 1929, discusses the subject briefly and it is mentioned by Olivier in his book "Meteors." But, no one seems to have pushed the idea to its logical conclusions.

The writer believes that not only do meteors produce such disturbances but that these disturbances may be made audible with a radio receiving set. Experiments along this line might lead to an explanation of the sounds which are sometimes said to be heard simultaneously with the appearance of bright meteors and fireballs, though no relation is apparent at present. He plans to try "listening in" for "meteor static" during some of the autumn and winter meteor showers and offers the following suggestions with the hope that other observers will do likewise.

An ordinary receiving set would probably do, but a four or five tube regenerative set, with long, high aerial, and broad tuning range would seem best. Listening in should be done with headphones in the field and as far from all sources of artificial static as possible. While the Perseids in August would probably furnish the best opportunity for bright fireballs, the static from normal sources is so bad at this time of year that some of the autumn or winter showers would doubtless be the best.

STERLING BUNCH.

U. S. Weather Bureau, Knoxville, Tenn.

GENERAL NOTES

The lateness in mailing this issue is due partly to the delay in receiving some of the material for it and partly to the delay involved in communicating with the Editor who is conducting the Courses in Astronomy at the Columbia University Summer Session. However, as this is the number for September as well as for August, the delay is not a serious matter. The next issue, the one for October, will be mailed on October 1, as usual.

Colonel Frederico Oom, director of the astronomical observatory at Lisbon, Portugal, died on April 30, 1930.

Dr. R. G. Aitken, who has been in charge of the active administration of Lick Observatory since July 1, 1923, with the title of associate director, has been named director, the appointment to date from July 1. (*Science,* May 30, 1930.)

Mr. Clifford E. Smith, who for the past few years has been contributing "Planet Notes," has been appointed Associate Astronomer at the Chabot Observatory. This position includes the teaching of Mathematical Astronomy at Mills College.

Dr. Clyde Fisher, president of the Amateur Astronomers Association, left New York on June 17 on a trip to Iceland and the Scandinavian countries. He has gone on a joint mission for the New York Bird and Tree Club and the American Museum of Natural History.

Dr. F. H. Seares Honored. — At the annual commencement of the University of California on May 14 Mr. F. H. Seares, astronomer and assistant director of the Mount Wilson Observatory, was awarded the honorary degree of doctor of laws. (*Science,* May 30, 1930.)

Dr. Edward A. Fath, director of Goodsell Observatory and associate editor of this magazine, left Northfield, Minnesota, early in June, with his family, by automobile for California. Dr. Fath will visit the Flagstaff Observatory as well as the observatories on the Pacific Coast on his journey.

Mr. O. H. Caldwell, editor of *Electronics* and *Radio Retailing,* in a recent address under the auspices of the Amateur Astronomers Association in New York City, predicted an improvement in the conditions for radio reception this fall and next year. The prediction is based on the reduction in the number of sunspots, which causes the Kennelly-Heaviside reflecting layer to be higher, a condition favorable to long distance radio reception.

A Request for Financial Aid.—We are in receipt of a request from a young man now in Heidelberg, who has had considerable experience in observational work, for assistance to the amount of approximately thirty dollars a month to enable him to finish his astronomical studies. We publish this request here with the thought that it might come to the attention of some one wishing to make a contribution in this way. We shall gladly furnish additional details to any one desiring them.

Henry Dill Benner, who has been active in New York City in popularizing astronomy, has recently, according to a newspaper clipping, extended his efforts to Newark, N. J. He has organized there a branch of what he calls the Night Sky Club, which is to meet every favorable Tuesday and Thursday evening for the observation of the more familiar subjects in the sky.

The Forty-fourth Meeting of the American Astronomical Society, at the invitation of Professor Philip Fox, will be held at the Adler Planetarium and Astronomical Museum, Chicago, Illinois, September 3 to 5, 1930.

New Observatory Proposed.—The *Detroit News* for June 29 contains a full page article relative to preliminary conferences looking toward the establishment of a large observatory in Miami, Florida. Professor G. W. Ritchey, who has been experimenting with new forms of telescopes for some years, was called into the conferences. Mr. G. H. Lutz, who is proposing the use of stainless steel instead of glass in constructing mirrors for telescopes, also took part.

The Adler Planetarium and Astronomical Museum, recently built in Chicago announces a schedule for visitors as follows: Monday, Tuesday, Thursday, Friday, from 10 a. m. to 10 p. m., admission twenty-five cents; lectures at 11 a. m. and at 3, 8, 9, p. m. Wednesday, Saturday, from 10 a. m. to 5 p. m., admission free; lectures at 11 a.m. and 3 p.m. Sunday, from 2 p.m. to 5 p.m., admission free; lectures at 3 and 4 p.m. School children free mornings.

The residents of Chicago and visitors to this city are fortunate in having this opportunity of witnessing a most ingenious and instructive demonstration.

Fused Quartz Experiments.—It has been the good fortune of the J. W. Fecker establishment to be able to co-operate with the General Electric Company in their research work with fused quartz intended for use in optical instruments. The largest pieces thus far which have been ground and polished recently consist of lenses of 12″, 8″ and 7″ in diameter, and 60-degree prisms having a 5-inch square face, over a dozen pieces in all. These are to be used in ultra-violet spectrographs.

The General Electric Company staff, under the leadership of Dr. Elihu Thomson, is greatly to be praised in this accomplishment. The quartz material is of fine quality; a number of pieces are of even optical quality, and the results most gratifying.

The Two-thousandth Anniversary of Virgil's Birth, falls in the year 1931.

In the *Rivista di Fisica, Matematica e Scienze Naturali* (Serie II. anno 4, 1930, p. 341) Professor Pio Emanuelli of the Vatican Observatory has brought out what seems to him to be a chronological error which almost all the world has made in considering that the Virgilian bimillenary falls in the present year 1930.

On the contrary, on account of the absence of the year 0, between 1 B.C. and 1 A.D., the years B.C. are all of an unity in excess relatively to the years that they represent. Therefore, the year 70 B.C. (Virgil's birth year) is the year—69.

$$2000 - 69 = 1931$$

The bimillenary of Virgil's birth falls in the year 1931.

Observatory Being Erected at Miraflores. — Construction of an observatory to house a 5-inch equatorial telescope, recently secured by The Panama Canal from the United States Navy, is in progress. The building is being erected on a small hill a short distance to the northwest of the Miraflores filtration plant, and will be a circular structure 14 feet in diameter, with 6-inch concrete wall. It will be topped with a mobile steel dome equipped to travel on a circular track, permitting the use of the telescope toward all points of the compass and facilitating the observation of celestial bodies in all parts of the heavens.

The observatory is being established through the efforts of the Canal Zone Astronomical Society, with the assistance of the Canal administration, and is to be used for the instruction of students of the Canal Zone high schools and for Panama Canal employees interested in or associated with astronomical societies. Ground was broken for the building on April 11, and it is expected that the work will be completed in June.

The position of the center point of the pier on which the telescope will rest is: Latitude 9° 00′ 15″ North; longitude 79° 35′ 51″ West. (*The Panama Canal Record*, May 21, 1930.)

The Cometary Aphelia and the Trans-Neptunian Planet.—The recent discovery of the Trans-Neptunian object has offered the occasion for mentioning some investigations made a half-century ago by the French astronomer Camille Flammarion on the distance of the Trans-Neptunian planet as deduced from the aphelia of some comets (that of 1862 III, and those of 1532 and 1661).

It seems that Flammarion was the first in his work *Astronomie Populaire* (p. 661), published in November, 1879, to indicate the distance of the Trans-Neptunian planet from the cometary aphelia. On the same subject he published also two articles: one in the French *Nature* (January 3, 1880), the other in the review *L'Astronomie* (vol. 3, 1884, pp. 81-91).

However, in Chambers' *The Story of the Comets* (Oxford, 1909, p. 43) one reads: "Flammarion, making use of the labours of some who went before him, including especially an American named Kirkwood, who was great at coincidences, has worked out the idea in a way which has yielded some results too serious and interesting to be passed over. In addition to the Jupiter group, he finds that every major planet beyond Jupiter seems to have a group of comets revolving in elliptic orbits attached to it; and moreover, as there is a group of comets without a known planetary leader, he makes bold to speculate that this fact is a proof that a Trans-Neptunian planet exists and will one day be found." This idea was published by Flammarion as early as 1879.

I should like to know where the American, Kirkwood, published the results of his researches on this subject, prior to that of Flammarion.

Vatican Observatory, 1930 April 21. PIO EMANUELLI.

Aurora Observed.—A faint aurora was observed between $0^h\,10^m$ and $0^h\,35^m$ June 2 in the vicinity of North Winton, Ohio. The display consisted of two vertical streamers of yellow-white light, almost directly under the north celestial pole, and a faint diffuse light background. The streamers fluctuated continually, and at maximum brightness were about half as bright as the Milky Way. J. H. LOGAN.

3514 Cedar Springs Road Dallas, Texas, June 10, 1930.

An Unusual Aurora.—On the night of June 16, I was observing variable stars with a three-inch refractor. About 10:00 P. M. I noticed a bright streamer of aurora about 40° long and about ½° wide starting about 5° below Altair. It remained like this for about ten minutes, with little change except an increase in brightness. Then it began to widen and lengthen, until about a quarter of an hour later it was a perfect river of fire about two degrees wide, stretching from below Altair to Regulus south of the zenith. Its center was between Arcturus and the observer. It was at least a dozen times as bright as the Milky Way, and the color of the light was greenish. The fine detail was constantly changing in such a way that it seemed as though the band of light were a river flowing from east to west. After about half an hour the band broke up gradually and the fragments slowly faded. It remained bright in the region of Coma Berenices the longest. By 11:30, the display was completely over. At its height it interfered considerably with the visibility of fifth magnitude stars.

The following fireball was seen by a friend of mine on the night of June 15, about 12:30. His account was as follows: He was sitting in a parked car a mile north of Dwight, North Dakota. Noticing the reflection of a light on his windshield, he looked up and saw to the northwest a brilliant fireball, about 1° in diameter. It was greenish in color, about as bright as the moon four days from full, and had a train about 10° long, very brilliant and greenish in color. The meteor remained in view about twenty seconds, and disappeared behind some nearby buildings to the northward. Its flight was accompanied by a hissing noise. My friend was of the opinion that it fell somewhere near.

Christine, N. D., June 17, 1930. NOAH W. MCLEOD.

Zodiacal Light Notes

In recent years Dr. E. O. Hulburt, Naval Research Laboratory, Anacostia, D. C., has been elaborating a theory of the origin of aurorae. Briefly, the theory is that the energy of the aurora is borne to the earth not by flying charged particles but by ultra-violet light. Absorbed in the high atmosphere of the earth the ultra-violet light produces ions and electrons. Rapidly the ions migrate to the polar regions and there yield up their energy of formation as auroral light. In *Physical Review*, May, 1930, Dr. Hulburt extends this theory to account for the Zodiacal Light. In this connection the basic assumption is that fast-flying atoms or molecules are sprayed out in all directions from the sunlit atmosphere of the earth and are ionized by ultra-iviolet light. At distances beyond 30,000 km they form a long oval ring around the earth and then, reaching to a distance beyond the apex of the earth's shadow, the converging arms coalesce and form the Gegenschein. Thus, the Zodiacal Light is considered to be a sort of comet-tail phenomenon. The only point in which this theory agrees with Barnard's theory is in regarding the atmosphere as supplying the material for the Zodiacal Light. Barnard held that the Zodiacal Light and the Gegenschein are both produced by sunlight reflected in the body of the atmosphere itself. The question of the spectrum of the Zodiacal Light is an essential factor in Zodiacal Light theory and it is very desirable that a further examination of the spectrum should be made.

Northern Luminosity. Since the last report the Zodiacal Light was observed on the following dates: May 16, 21, 22, 23, 25, 27; June 12, 14, 15, 16, 18, 19, 20, 21, 22, 27, 29. On all other nights the moon or clouds made observations impossible. During May the evening Zodiacal Light was strong from the sunset point to the Sickle of Leo. It became increasing diffuse in extent. With June

came a change; the Light began to sheer off along the northwest horizon towards the north point of the meridian. In fact, from north temperate latitudes hardly anything of the Zodiacal Light can be glimpsed along the ecliptic through Leo, Virgo, Libra, and Scorpio during June and July. The virtual invisibility of the Light when the ecliptic runs low in the south during these months is due probably to the tilt of the north pole area towards the sun causing the oblateness of the earth to shut off the light from the night sky. But the observer is rewarded by watching the hazy luminosity in the northern sky which characterizes this period of the summer solstice. On various nights during the past month the writer traced it from the northwest around to the northeast, the luminosity being enhanced first west of the meridian, then, later, east of the meridian. Though fainter than the Zodiacal Light as seen at its best in the west at the vernal equinox, this luminosity is easily suggestive of the Zodiacal Light. Its altitude, not uniform night by night, ranged from 10° to 15° and 20°. The contrast between the darkness of the sky above Polaris and the luminosity below Polaris was strikingly marked. Observations were made between 9:30 P.M. and 2:00 A.M.

Moon Zodiacal Light. On June 14, moonrise at 10:40, a narrow triangular band of light was seen at 10:20 extending from the place of moonrise along the ecliptic zone towards Saturn in Sagittarius. On account of the low angle with the ecliptic the demonstration was difficult to determine but it was unmistakable. A few minutes before moonrise the band on the horizon spread in fan-like form north and south as the sky brightened generally. On account of the relative nearness of the moon as compared with the sun's distance, together with the much fainter intensity of moonlight in the gibbous phase, it should be noted that moon twilight is necessarily very brief and faint as contrasted with sun twilight.

Aurorae. Aurorae were observed on May 30 and 31. On June 27, superimposed on the hazy luminosity, a bright band about 3° in breadth and 5° above the horizon extended east and west, its extremities being fairly equidistant from the meridian. It was probably auroral in character but was quiet and steady, unlike the aurorae of May 30 and 31 which were marked by bulbs and streamers. On June 27 the bright band was seen first at 10:00 P.M.; at 11:20 it had disappeared, only the hazy luminosity remaining.

Observers are reminded that from the middle of September the morning Zodiacal Light and the Gegenschein will be well placed for observation. It is hoped that reports of such observations will be received.

W. E. Glanville.

The Rectory, New Market, Maryland.

Aurora of May 30, 1930

Location: Whitmore Lake, Mich., ten miles north of Ann Arbor.

10:10 First noticed band forming in N with end points on the NE and NW horizons, and with the center of the arc 10° above horizon at direct N.
10:35 Streamers forming rapidly. Of green color and rapidly fluctuating.
10:27 Streamers and band becoming very bright. Three curtains seen in NWN.
10:30 Streamers still brighter. Curtains unfurling, especially in NW. In all, four curtains seen, two in NW, one at direct N, and one, the brightest of all, in the NE.
10:32 Black band appearing, extending in a large arc over the original band, from the horizon at NWW (under Castor and Pollux) to NEE (under Deneb in Cygnus).
10:35 Curtains unfolding in NW.
10:37 One streamer shoots up to 50° above horizon in NW.
10:38 Band split in direct N.

10:39:30 Streamers and curtains disappearing in NE, only band remaining there.
10:40 All streamers disappeared, except for one, narrow and up to 40° above horizon in NW. (Through to Ursa Major.)
10:40:45 Narrow streamer seen only under band. No curtains.
10:41 Only diffuse light. No definite streamers. Band fainter.
10:42 No streamers. Only band, which is now in a larger arc, with its mid-point about 15° above direct N.
10:52 Bright streamers under the dark band in N. Diffuse streamers up to 30° at nearly all points above the band.
10:57 Double band appearing. Second band in arc with mid-point at 30° above the north point, and with end points at practically east and west on the horizon—a very large arc.
10:58 Extremely bright and compact curtain seen under the smaller band in NWN. By far the brightest of any one part of the display so far, but quite ill-defined in form, and rather diffuse.
10:58:30 Bright curtain unfurling and growing in size.
Only intermittent watch kept from 10:59 to 13:25, due to the return trip to Ann Arbor and from there out to my observatory, a distance of about 13 miles south.
Location: While riding in car.
12:00 Peculiar pulsating light noticed. Pulsations occurring about one every second, in the form of a very faint band of light rising from the N, whisking up to 25° or 30°, and then disappearing. A truly uncanny spectacle.
Location: Observatory, three miles east of Ann Arbor.
13:26 Band lighting up again and becoming prominent. A few streamers in N up to 20°.
13:27 More streamers. Brightest one in NE.
13:30 Streamers much brighter and up to 30° above horizon. One exceptionally bright in NW.
13:31 Band very prominent. Fleecy streamers overlapping one another under band in NW.
13:34 Band seen to be crooked, being deflected in NEN and diminished in brightness in the NW. Only a very few streamers, and these very insignificant.
13:42 Bright irregular streamers in all parts of the sky between 30° and the horizon (above the band). A general jumbling of everything at once.
13:43 One very prominent streamer in NW up to 30° above horizon.
13:45 Streamers diminishing generally. There have been no curtains since the exceptional one at 10:58. Prominent streamer up to 30° in NW still exists.
13:59 All activity much diminished.
No watch kept from 14:00 to 14:45.
14:47 Band becoming brighter. Pulsating commencing on an even larger scale than at 12:00, and at a rate of about three pulsations per second. An amazing sight.
14:48 Still pulsating. No streamers developing. Somewhat fainter.
14:54 Still pulsating, but noticeably fainter and pulsations disappearing at 15° to 20°above horizon rather than at greater heights as before. Band still to be seen.
15:02 Still pulsating, but only in NE. No activity of any sort in NW,—not even the band.
15:10 Pulsations practically ceased and band hardly visible with no streamers at the very first peep of dawn.

SUPPLEMENTARY REPORT.

May 31 Faint band noticed occasionally during night in N. No streamers seen.
June 1 Faint band seen at 10:20. No notes taken.

CLINTON B. FORD.

904 Forest Avenue, Ann Arbor, Michign.